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## V.

# THE ZODIACAL LIGHT.

By Arthur Searle.

Presented October 10, 1883.

At the outset of any inquiry into previously neglected phenomena, the observations or experiments which can be made are necessarily somewhat vague. The questions to which we endeavor to obtain replies are drawn up more or less at random, and this is even more true of the hypotheses by which we relieve the monotony of our first observations. A considerable improvement in the conditions governing our inquiries will be made when we begin to discover the details to which our attention should be directed in order to arrive at the more general knowledge originally desired. But the discovery of these details usually demands a patient examination of the confused mass of material first collected by observation. It is not so likely to be forwarded by the formation of new hypotheses, although it is undoubtedly true that a lucky guess may give a fortunate direction to our work, upon which we should have been long in deciding if we depended only upon the study of what had already been observed. Still, it is never advisable to neglect this study in the hope that it can be saved by guessing.

For these reasons, it has seemed to me worth while to collect, and partially to reduce, upon a uniform system, the published work of several observers of the zodiacal light. I have confined my attention for the present to their evening observations, as the morning observations would in any case require separate consideration, and as it has been difficult to find time, under the pressure of other occupations, for even the limited discussion herewith presented. From Serpieri's study of the observations of Jones (to be further mentioned below) we have, moreover, some means of comparing the most important published series of morning observations with the evening observations of the same observer.

The data here collected relate to the approximate position of the zodiacal cone in the visible hemisphere of the sky, to the elongation of the vertex, and to the latitudes of the northern and southern boundaries at successive elongations 30° apart. The term "elongation" will be used throughout this discussion to denote a difference of longitude between the Sun and some other point, not the direct angular distance of that point from the Sun. Since the zodiacal light, however it may be produced, has plainly some relation both to the Sun and also to some great circle not much inclined to the ecliptic, the arrangement of the observations according to elongation (in the sense just stated) appears to be the most natural which can be adopted. The interval of 30° is arbitrary. The knowledge of the observations gained by reducing them now inclines me to think that 20° would have been preferable, although it would have increased the labor of the work; but I could not have the information necessary to settle this question at the beginning of the reductions.

In the following pages, I shall have occasion to cite a number of works, the titles of which are here given, with the abbreviations afterwards used to designate them. Figures following an abbreviation will indicate the page of the corresponding work to which reference is made.

A. Argelander, Aufforderung an Freunde der Astronomie. (Pp. 122–254 of Schumacher's Jahrbuch für 1844.)

C. Celoria, Sopra alcuni Scandagli del Cielo. (Pubblicazioni del Reale Osservatorio di Brera in Milano, N. XIII.) Milano, 1877.

D. Dechevrens, La Lumière Zodiacale. Zi-Ka-Wei (China), 1879.

G. Geelmuyden, Remarques sur la Théorie de la Lumière Zodiacale. (Separataftryk af Archiv for Mathematik og Naturvidenskab.) Kristiania (1882?).

*H. Heis, Zodiacallicht-Beobachtungen in den letzten 29 Jahren 1847–1875. I. Veröffentlichung der königl. Sternwarte zu Münster. Münster, 1875.

Hb. Humboldt, Cosmos, Vol. I. (Bohn's Scientific Library.) London, 1849.

*Jj. Jones, Observations on the Zodiacal Light. (United States Japan Expedition, Vol. III.) Washington, 1856.

Jq. Jones, Observations at Quito. (Am. Journal of Science for November, 1857, Vol. XXIV. pp. 374–385.)

L. Loewy, Remarques sur la Méthode proposée par M. le Professeur Pritchard pour la Mesure de l'Éclat des Astres. (Monthly Notices of the Royal Astronomical Society, Vol. XLII. pp. 91–94.)

Ls. Lewis, Note on the Zodiacal Light. (Am. Journal of Science for December, 1880, Vol. CXX. pp. 437–445.)
M. Müller, Photometrische Untersuchungen. (Publicationen des Astrophysikalischen Observatoriums zu Potsdam. Nr. 12. Potsdam, 1883.)
*S. Schmidt, Das Zodiacallicht. Braunschweig, 1856.
Sp. Serpieri, La Luce Zodiacale studiata nelle Osservazioni di G. Jones. (Memorie della Società degli Spettroscopisti Italiani. Appendice al Volume V., Anno 1876, pp. 49–161.)
T. Observations de la Lumière Zodiacale à Toulouse. Notes de M. Gruey. (Comptes Rendus des Séances de l'Académie des Sciences, Tom. LXXIX. pp. 1250–1253; Tom. LXXX. pp. 903–906.)
W. Wolf, Description du Groupe des Pléiades. (Annales de l'Observatoire de Paris. Mémoires, Tom. XIV. Deuxième Partie. Pp. A. 1 — A. 81.)

Tables X. to XXXIV. inclusive, in the Appendix following the present discussion, exhibit the data obtained from the works by Jones, Heis, and Schmidt, which are marked with asterisks in the list above. Besides his own observations, Heis reports others by Weber, Eylert, and Neumayer. Notwithstanding the small number of observations by Eylert and Neumayer, the geographical positions at which they were taken make them at least interesting, if not very conclusive. It may appear superfluous to print the results of the separate observations, as is done in Tables X., XI., and XII. But while some readers may be dissatisfied with the subsequent course taken in the reductions, they may still be able to make use of the separate observations, as here arranged upon a uniform system for each observer. I have myself had occasion to regret that Serpieri was prevented by want of space (Sp. 61) from publishing the numerical tables by which he had represented all the observations of Jones.

It has also seemed desirable to include in the Appendix a few tables and a small chart intended to facilitate approximate determinations of the position of the zodiacal light in the visible hemisphere. To make such determinations with accuracy seems needless in our present state of knowledge with regard to the zodiacal light, especially as the time of the observations is often given without much precision. The Appendix contains a description of all the tables included in it, which will make it unnecessary to consider them further in this place. I may accordingly pass at once to the conclusions which they suggest to me.

The first deduction which Jones himself made from his observations (Jj., Introduction, xvi.) was that the place of the zodiacal light with respect to the ecliptic depended upon the position of the ecliptic in the visible hemisphere; so that the light was comparatively deficient on the lower side of the ecliptic. As Jones states it, when he was north of the ecliptic, the main body of the light was also north of it; when he was south of the ecliptic, so was the main body of the light; when he was nearly on the ecliptic, the light was equally divided by the ecliptic, or nearly so. He also found that in a large majority of cases a change in the zenith distance of the pole of the ecliptic during a single evening was accompanied by a progressive change of the zodiacal light, in accordance with the rule just stated.

A cause, obviously tending to produce an effect of this kind, is well known to exist. The atmosphere of the Earth absorbs light with increasing efficiency as the line of sight descends from the zenith towards the horizon. Accordingly, the brightness of the zodiacal light on the lower side of the ecliptic should be diminished relatively to that of the light at the same distance from the ecliptic on the upper side. But before accepting this explanation of the law discovered by Jones, we must see whether the law itself is confirmed by the experience of other observers, and whether the known amounts of atmospheric absorption at different altitudes exhibit a reasonable degree of correspondence with the observed effects. The subject has been debated by Geelmuyden and Groneman (G. 83), but seems to need the different treatment here proposed.

A general view of the result for the elongation 60° is afforded by Table I., below. The first two columns, headed "Observer" and "Group," relate to the arrangement of the observations in the final tables of the Appendix. The "Diffuse" Light observed by Jones is not here taken into consideration. The next four columns contain the latitude of the observer's station; the zenith distance of the north pole of the ecliptic, here called the inclination of the ecliptic; the elongation of the zenith, by which is meant the excess of its longitude over that of the Sun; and, finally, the zenith distance of the Sun. The next column gives the number of observations upon which the preceding results directly or indirectly depend, as is explained in the Appendix. The remaining columns relate to the position of the zodiacal light with respect to the ecliptic, 60° from the Sun. The first of these columns contains the number of observations upon which the result depends. A strict reduction would have required the number of the preceding column always to agree with this; that is, the data for the position of the ecliptic in the visible hemisphere should have been calculated separately for the separate observations. As it is, they apply only approximately to the mean results at particular elongations; but when these results are derived from considerable numbers of observations, the approximation will be sufficient for the present purpose. Means are provided in the Appendix for the further reduction of the work, if that should appear desirable, but I have not hitherto found time to attempt it.

The column of numbers is followed by two columns giving the latitude of the axis of the light, and its half extent in latitude. By the latitude of the axis is meant the mean of the latitudes of the northern and southern boundaries. These data are derived exclusively from those observations from which the latitude of the axis can be separately determined. In the cases of Heis and Weber the number of observations for the half extent in latitude is sometimes slightly inferior to that here given, which relates to the latitude of the axis, as will be seen in Table XXVIII. The next two columns of Table I. contain the zenith distances of the northern and southern boundaries corresponding to the previous data. They are followed by the amounts of atmospheric absorption due to each of these zenith distances according to Müller, expressed in terms of stellar magnitude by dividing each logarithm of the original table (M. 59) by 0.4. The last column of Table I. gives the difference between the amounts of absorption in the preceding columns, expressed as a positive quantity when the absorption at the southern boundary exceeds that at the northern.

In the discussion of these results I shall first consider the question raised by Serpieri (Sp. 111), whether Jones was right in referring the apparent changes in the place of the light to the corresponding changes in the place of the ecliptic in the visible hemisphere, and whether they ought not rather to be referred to the geographical position of the observer in latitude. In the case of Jones, which Serpieri was discussing, the changes in the place of the ecliptic are very generally in accordance with the movements of the observer. But the second group of observations in Table I. exhibits a decided interruption of this accordance. Since it may perhaps be conjectured that the method of reduction is here at fault, I have determined the position of the ecliptic for each of the twenty-four observations of this group. The new reduction makes no change in any of the data, except that the mean result for the "elongation of the zenith" becomes 122°, instead of 123°, as in the table. This alteration is entirely insignifi-

## TABLE I.

| Observer. | Group. | Lat. of Obs. | Incl. of Ecl. | Elong. of Zen. | Z. D. of Sun. | Total no. Obs. | Elongation 60°. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | No. | Lat. of Axis. | Half Ext. | Z. D. | | Absorption. | | Diff. Absorption. |
| | | | | | | | | | | N. | S. | N. | S. | |
| | | ° | ° | ° | ° | | | ° | ° | ° | ° | | | |
| Jones . . . . | 1 | +30 | 43 | 125 | 113 | 144 | 69 | +4 9 | 8.0 | 63 | 74 | 0.28 | 0.60 | +0.32 |
| " . . . . | 2 | +21 | 53 | 123 | 116 | 58 | 24 | +3.2 | 7.6 | 61 | 71 | 0.25 | 0.48 | +0.23 |
| " . . . . | 3 | +34 | 65 | 124 | 121 | 52 | 46 | +1.9 | 6.6 | 63 | 69 | 0.28 | 0.42 | +0.14 |
| " . . . | 4 | +27 | 79 | 124 | 123 | 87 | 70 | +0.9 | 8.8 | 60 | 64 | 0.23 | 0.30 | +0.07 |
| " . . . . | 5 | +22 | 88 | 127 | 127 | 42 | 16 | +0.5 | 7.3 | 67 | 67 | 0.36 | 0.36 | 0.00 |
| " . . . . | 6 | + 4 | 104 | 118 | 117 | 39 | 35 | −1.6 | 8.1 | 60 | 55 | 0.23 | 0.17 | −0.06 |
| " . . . . | 7 | −30 | 142 | 131 | 114 | 26 | 20 | −3.4 | 7.6 | 81 | 70 | 1.07 | 0.45 | −0.62 |
| Heis . . . . . | 1 | +52 | 46 | 129 | 117 | 20 | 20 | +4.4 | 10.2 | 64 | 78 | 0.30 | 0.82 | +0.52 |
| " . . . . . | 2 | +52 | 53 | 117 | 111 | 68 | 63 | +2.5 | 10.2 | 55 | 68 | 0.17 | 0.39 | +0.22 |
| " . . . . . | 3 | +52 | 60 | 116 | 112 | 95 | 85 | +2.5 | 9.5 | 54 | 65 | 0.16 | 0.32 | +0.16 |
| Weber . . . . | 1 | +52 | 43 | 116 | 107 | 7 | 6 | +2.3 | 12.3 | 56 | 75 | 0.18 | 0.65 | +0.47 |
| " . . . . | 2 | +52 | 54 | 114 | 110 | 35 | 35 | +2.7 | 10.4 | 54 | 66 | 0.16 | 0.34 | +0.18 |
| " . . . . | 3 | +52 | 60 | 114 | 110 | 45 | 45 | +2.1 | 8.6 | 53 | 63 | 0.15 | 0.28 | +0.13 |
| Eylert; Neumayer | 1 | +30 | 63 | 120 | 117 | 5 | 5 | +3.0 | 8.6 | 59 | 67 | 0.22 | 0.36 | +0.14 |
| " | 2 | +15 | 77 | 119 | 118 | 3 | 3 | +2.7 | 6.0 | 57 | 60 | 0.19 | 0.23 | +0.04 |
| " | 3 | −11 | 91 | 118 | 118 | 7 | 7 | +0.6 | 5.7 | 58 | 58 | 0.20 | 0.20 | 0.00 |
| " | 4 | −31 | 104 | 111 | 110 | 9 | 9 | −1.2 | 4.0 | 54 | 51 | 0.16 | 0.13 | −0.03 |
| Schmidt. . . . | 1 | +50 | 47 | 124 | 114 | 4 | 2 | +2.0 | 5.5 | 65 | 73 | 0.32 | 0.56 | +0.24 |
| " . . . . | 2 | +50 | 55 | 130 | 121 | 11 | 10 | +2.0 | 4.4 | 70 | 75 | 0.45 | 0.65 | +0.20 |
| " . . . . | 3 | +50 | 61 | 116 | 112 | 1 | 15 | +2.1 | 4.0 | 57 | 61 | 0.19 | 0.25 | +0.06 |
| " . . . . | 4 | +42 | 69 | 106 | 105 | 7 | 6 | +1.3 | 2.7 | 47 | 50 | 0.10 | 0.12 | +0.02 |

cant, and makes no noticeable difference in the result for atmospheric absorption. It will be seen that the observations of this group were made in a more southern latitude than those of the next two groups, and at about the same latitude as that in which the observations of the fifth group were made. Meanwhile, the apparent shifting of the axis follows the progressive change of the inclination of the ecliptic, entirely in accordance with the original theory of Jones. In order to form an independent judgment upon the subject, the work of Serpieri must be consulted, and the graphical arrangement of the observations, by which he supports his argument, must be examined. My own conclusion is that the view taken by Jones was correct.

All the evening observations of Heis and of Weber were made near the fifty-second parallel of latitude, where the zodiacal light can only be seen for the few months during which the zenith distance of the north pole of the ecliptic is near its maximum at the time of observation. Under more favorable circumstances the fixed stations of these observers would have aided us materially in distinguishing the cause of the apparent movement of the zodiacal light in latitude. So far as it goes, the evidence of Heis is in favor of a change due to an altered position of the ecliptic, or rather to the resulting difference in atmospheric absorption; for while the inclination of the ecliptic changes by seven degrees in passing from each group of observations to the next, the change in the final column of Table I. is 0.30 between Groups 1 and 2, and only 0.06 between Groups 2 and 3. The corresponding changes in the latitude of the axis are 1°.9 and 0°.0. The evidence of Weber, taken without regard to the number of observations in each group, would not support the hypothesis of regular change; but the number of observations in his first group is only six, and this circumstance leaves us without any distinct result in his case. The mean result for Heis and Weber, with equal weights for the separate observations, would indicate a progressive change in the latitude of the axis.

The small number of the observations of Eylert and Neumayer makes the result from them inconclusive. It is of interest, because we have no other observations made in southern latitudes except those of Jones, and it tends to confirm the principle established by that observer. But in this instance a change in terrestrial latitude accompanies that of the position of the ecliptic.

Schmidt's observations, if they were sufficiently numerous, would confirm Serpieri's hypothesis. The axis remains at two degrees of north latitude until the observer changes his station to Italy, when it begins to approach the ecliptic. But neither of the four groups contains many observations, and there are some peculiarities in Schmidt's results, to be considered hereafter, which may partially account for the discordance between them and some of the others.

Setting aside, for the present, the consideration of atmospheric absorption, my conclusions from the observations thus far considered are, first, that the experience of Jones with regard to the shifting of the light is confirmed by that of other observers; secondly, that he was right in connecting the change with the altered position of the ecliptic in the visible hemisphere, rather than with the change in terrestrial latitude from one place of observation to another.

In the absence of the strict reduction mentioned above (p. 149), only a very general conclusion can be drawn from the observations at the elongations 30° and 90°, since their number is often comparatively small. It will appear by inspection of Tables XXV., XXVIII., XXXI., and XXXIV. that the observations of Jones, Heis, and Weber, made at these elongations, agree on the whole with the results obtained at the elongation 60°. The other observers furnish very little material for a conclusion, and the results are irregular.

We have still to consider the observations by Jones of what he called the "Diffuse" Light. Only those at the elongation 90° are sufficiently numerous, in comparison with the total numbers of observations used in determining the successive positions of the ecliptic, to allow us to attach much significance to the result from them. Still, the observations at 60° may be worth examining, and they are accordingly included in Table II. The first two columns of this table give the numbers of the successive groups of the observations of Jones and the total number of observations belonging to each group. These data are repeated from Table I. It is unnecessary to repeat the corresponding data for the position of the ecliptic. The rest of Table II. consists of two parts, relating to the "Diffuse" Light at the respective elongations 60° and 90°. Each part gives data corresponding to those for the "Stronger" Light found in Table I.

## TABLE II.

| Group. | Total no. Obs. | Elongation 60°. | | | | | | | | Elongation 90°. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | Lat. of Axis. | Half Ext. | Z. D. | | Absorption. | | Diff. Absorption. | No. | Lat. of Axis. | Half Ext. | Z. D. | | Absorption. | | Diff. Absorption |
| | | | | | N. | S. | N. | S. | | | | | N. | S. | N. | S. | |
| 1 | 144 | 36 | +5.9° | 21.3° | 54° | 86° | 0.16 | 2.04 | +1.88 | 82 | +5.1° | 19.7° | 34° | 67° | 0.04 | 0.36 | +0.32 |
| 2 | 58 | 15 | +5.3 | 24.2 | 52 | 80 | 0.14 | 0.98 | +0.84 | 26 | +1.6 | 16.1 | 35 | 60 | 0.04 | 0.23 | +0.19 |
| 3 | 52 | 22 | +2.0 | 21.7 | 58 | 76 | 0.20 | 0.70 | +0.50 | 44 | +3.8 | 15.5 | 33 | 50 | 0.04 | 0.12 | +0.08 |
| 4 | 87 | 48 | +1.7 | 21.6 | 62 | 70 | 0.26 | 0.45 | +0.19 | 50 | +2.2 | 17.8 | 45 | 53 | 0.09 | 0.15 | +0.06 |
| 5 | 42 | 16 | +3.8 | 17.4 | 63 | 69 | 0.39 | 0.42 | +0.03 | 19 | +1.3 | 15.5 | 38 | 39 | 0.05 | 0.06 | +0.01 |
| 6 | 39 | 17 | —1.9 | 20.8 | 66 | 56 | 0.34 | 0.18 | —0.16 | 17 | —2.9 | 15.1 | 38 | 27 | 0.05 | 0.02 | —0.03 |
| 7 | 26 | 5 | —6.8 | 19.4 | 88 | 59 | 3.10 | 0.22 | —2.88 | 7 | —4.3 | 18.3 | 75 | 44 | 0.65 | 0.08 | —0.57 |

These results exhibit more irregularity than those found for the "Stronger" Light, but seem on the whole to agree with them. The view of Serpieri, however, is supported by the observations of the "Diffuse" Light at the elongation 90°. The observations of the second and fifth groups were made, as we have seen, in about the same terrestrial latitude, and give approximately the same value for the "latitude of the axis," while larger values are furnished by the third and fourth groups, the observations of which were made at more northern stations. It will be sufficiently apparent by inspection of Table X. that no very great change would be made in the assumed position of the ecliptic, or of the observer's latitude, by computing them for the second group from those observations only in which the latitudes of the boundaries of the "Diffuse" Light were observed at the elongation 90°. It is also apparent that the small mean value here obtained for the "latitude of the axis" results from the extension of the "Diffuse" Light, near its vertex, towards the south, which Jones repeatedly observed towards the end of October, 1853. In order to decide whether this extension has any bearing upon the questions now before us, the work of Jones must be consulted. Considering the probable difficulty of observing the "Diffuse" Light in the neighborhood of the Milky Way, it does not seem to me that we are warranted in attaching much significance to the location, during a single fortnight, of the small part of its southern boundary which could be laid down upon the charts.

The observations of zodiacal light at elongations of 120° or more are too few for profitable discussion in the inquiry immediately before us. In what follows, I shall assume that the zodiacal light shifts its place in latitude according to the changing position of the ecliptic in the visible hemisphere. To decide whether this change can reasonably be explained by atmospheric absorption will demand some information respecting the brightness of the zodiacal light, the relative brightness of its different parts, and the nature of the lines considered as its boundaries by different observers. No precise knowledge has yet been gained upon these subjects, but we are not entirely in ignorance with regard to them.

The general brightness of the zodiacal light has been usually estimated by comparisons made with the Milky Way. Humboldt found it equal at times to the region of Sagittarius (Hb. 126). Weber repeatedly noticed that the zodiacal light was brighter than the Milky Way, and on one occasion nearly twice as bright as its brightest portions, (1874, March 5, H. 52; see also H. 37, 40, 43, 54). Eylert makes very similar estimates (H. 47, 49). In Schmidt's general description of the light (S. 15), he says that its brighter portions, under favorable conditions for observation, exceed the mean brightness of the Milky Way. On January 26, 1848, and on March 9, 1850 (S. 31, 38,) he found the zodiacal light brighter than the brightest parts of the Milky Way. He communicated to Heis (H. 27) a more precise observation made at Athens in April, 1862, when the lower and middle part of the light appeared to be from five to six times as bright as the parts of the Milky Way at the same altitude in Argo and Cepheus. Jones occasionally describes portions of the zodiacal light as equally bright with specified regions of the Milky Way (Jj. 150, 152, 166), and remarks the simultaneous appearance of both objects, March 25, 1854 (Jj. 258). On two occasions he mentions the superior brightness of the zodiacal light (Jj. 134, 298). The luminous arch which he afterwards observed at Quito was approximately equal to the Milky Way in brightness, but on the whole seems to have been slightly inferior to it (Jq. 377). Gruey's observations at Toulouse in February, 1875 (T. 905), make the zodiacal light about as bright as the Milky Way; sometimes a little brighter or fainter. See also the account of Lewis (Ls. 439). From all these remarks it appears pretty certain that the zodiacal light and the Milky Way are objects of the same general order of brightness, so that if the light of equal areas of their brightest portions is supposed to be concentrated at single points, the stars so formed would not differ by more than two magnitudes, and would probably differ by less than one magnitude.

The relative intensity of different parts of the zodiacal light seems not to have been investigated. We have reason to think, however, that the light fades out by degrees as it extends farther from the Sun, and also as it extends laterally from its medial line, or "axis." This appears more or less distinctly in all accounts of the phenomenon, but for the most part only indirectly, by the difficulty experienced in tracing the boundaries of the light, especially towards the vertex. An object as bright as many well-marked parts of the Milky Way, and of nearly uniform brilliancy, would of course be located without trouble. But there is also positive testimony to the same effect. Schmidt tells us (S. 15) that the light increases towards the horizon until checked by the denser strata of the atmosphere, and also mentions (S. 61) the comparative indistinctness of the vertex and the unequal intensity of different parts of the light. Jones makes a similar statement in his Introduction (Jj. xi). He also says (Jj. 346) that the "Diffuse" Light "faded away imperceptibly at its edges"; and that the "Stronger" Light "dims as it ascends." The lower portions were quite distinct on another occasion (Jj. 376) before the night had deepened sufficiently to show the remainder. The general description by Lewis (Ls. 438) confirms the preceding accounts.

The nature of the boundaries adopted by different observers apparently differs very considerably. In the case of Schmidt, we see by his account (S. 23) that the boundary is a line within the extreme limits of the light, selected as one which can be followed among the stars with a certain degree of confidence. The comparative narrowness of the light recorded by this observer, which will appear for the elongation 60° on inspection of Table I., is in conformity with the method of observation just described.

Heis and Weber probably attempt to include all the visible light within the boundaries which they adopt. This gives them a zodiacal cone wider at 60° than that of Schmidt. The "Stronger" Light of Jones is of an intermediate width; his "Diffuse" Light extends much farther than any other observer has carried the limits of the light. The form of the various cones or columns thus produced may require separate consideration at some other time; for the present, we have merely to notice the arbitrary character of the boundary. It appears to me a fair inference that the light fades away very gradually towards its edges, and this conclusion will be approved, I think, by most observers, as one accordant with their general impression of the appearance of the zodiacal light. Other occupations have always prevented me from making any careful comparisons of the kind required to decide the question; but so far as I can judge from casual observation, the light fades out as above described.

The effect produced by the zodiacal light in dimming the light of stars has apparently been seldom observed; at all events, the few results of such work which I have found on record are not sufficient to permit any inference except that the light is too faint to interfere materially with the perception of even a small star. Observations of this kind were proposed by Argelander (A. 156), but must be very numerous and frequent to make them of value.

Since the Milky Way is at present our only standard of comparison for the zodiacal light, it is desirable to form some idea of its brightness. Our chief resource must probably be the results obtained by the star-gauging observations of W. Herschel and others. The following ratios of the maximum and minimum density of the stars found in different regions of the sky appear in Celoria's discussion (C. 45): —

| | |
|---|---|
| Uranometria Nova, Zone 0° to +6° | 5.15 |
| " " " −10° " +16° | 5.29 |
| Durchmusterung, to magn. 7.5 | 3.94 |
| " " 8.0 | 2.90 |
| " " 9.5 | 4.20 |
| Milan observations | 3.04 |
| Herschel's gauges | 62.78 |

The manner in which these ratios were obtained is fully explained in the work of Celoria. Although the regions considered are of limited extent in declination, they are sufficiently large to entitle the results derived from them to much confidence. The regions of maximum stellar density are well known to be in the Milky Way, and it is needless here to repeat the evidence of this fact. The Milan observations were made by Celoria with a telescope of good quality, 10 cm. in aperture, and capable of showing stars of the eleventh magnitude under favorable conditions (C. 3).

The general result is obviously that stars of medium magnitudes are much more uniformly distributed over the sky than the faint stars which make up the mass of the Milky Way, and somewhat more uniformly than the stars visible to the naked eye. From the Milan observations alone we should infer that the ratio of light from the Milky Way, in its brighter regions, to that from the darker portions of the sky, might be expressed in stellar magnitudes by about 1.2. This assumes that the average magnitude of the stars observed in the brighter and fainter regions was the same, and the assumption is probably justifiable. But with Herschel the case was very different. In the darker regions, his telescope showed no greater abundance of stars than Celoria's, while it disclosed twenty times as many in the brightest regions. It should be noted, however, that the region explored at Milan did not include the immediate neighborhood of the galactic pole. The numbers for Celoria's standard area are as follows (C. 46): —

Celoria: maximum 15.16, minimum 4.98.
Herschel: " 301.16, " 4.81.

The 286 additional stars distinguishable by Herschel's instrument in the brighter region must apparently be regarded as two or three magnitudes fainter, on the average, than the fifteen stars visible to both observers. If they were of equal magnitude with these fifteen, they would furnish nineteen twentieths of the light emitted by the region (neglecting any stars still fainter), which means that they would increase the brightness of the region by an amount to be denoted by 3.2 magnitudes. As it is, we cannot assume this increase of brightness to exceed one magnitude. Since we found the result 1.2 for the difference of magnitude between the regions of maximum and minimum density according to the Milan observations, we shall have a difference of little more than two magnitudes as the result of Herschel's observations according to Celoria's reduction.*

If the inequality of distribution among stars too faint to be separately visible to Herschel should resemble or surpass that of the fainter stars which he observed, a higher estimate of the relative brightness of the Milky Way would result. But in the absence of further information, we may perhaps make a sufficient allowance for these stars, by considering the Milky Way to be two magnitudes brighter than the mean, instead of the minimum, brightness of the sky. According to this estimate, the brightest parts of the zodiacal light may commonly be three or four magnitudes brighter than the surrounding sky. But at 60° from the Sun, it is not likely that the zodiacal light exceeds the Milky Way in brightness, and for that elongation we may suppose that its middle portions will not be more than two magnitudes brighter than the sky around it. At its assumed edges, the difference of magnitude will depend upon the choice of the observer with regard to the nature of the boundary to be employed in his observations. Suppose that he endeavors to include all the light which he can see, and that he distinguishes differences of a single tenth of a magnitude, so that, at the boundary which he adopts, the zodiacal light is brighter than the sky beyond it by one tenth of a magnitude. This may perhaps be the case with Heis and Weber (see p. 156). Taking their result of about 10° for half the extent of the light in latitude (see Table I.), we should have a variation of about one fifth of a magnitude for every degree, if we suppose the light to vary uniformly, on the scale of stellar magnitude, so as to reduce the excess of brightness from two magnitudes in the middle to one tenth of a magnitude near the boundary. If the observer, in fixing the upper and lower boundaries of the light, aims at equality of brightness in the opposite points through which he draws them, an excess of absorption at the lower edge amounting to one fifth of a magnitude will consequently set back the lower boundary about a degree. This conclusion is of no value as a representation of the true process of observation, but it indicates that the differences of atmospheric absorption required to effect a sensible displacement of the boundaries are probably not large. In this way, it appears to me to strengthen the probability that absorption is an important, and perhaps the only, cause of the variations of the zodiacal light in latitude. It may reasonably be anticipated that future observation will prove the diminution of the light from the middle towards the edges to be not uniform, but much more gradual near the edge than at some other places. In this case, the effect of absorption would at first be considerably greater than has just been supposed. But it would be useless, in the absence of direct evidence upon the subject, to adapt an imaginary gradation of light to the results obtained by observation for the displacement of the zodiacal cone. At present, we cannot even assert with confidence that the observers have aimed at equality of brightness between opposite points in the boundaries which they have drawn.

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* See also, for confirmation, the Cape Observations of the younger Herschel, pp. 373–383.

Among the facts recorded with regard to the zodiacal light is one which independently suggests the probability that the observation of the boundaries is influenced by atmospheric absorption, although it gives no information respecting the extent to which it may displace them. This fact is the customary distinctness of the lower edge as compared with the upper. It is mentioned by Schmidt in his general description of the zodiacal cone, and also later (S. 15, 27), and is repeatedly noticed by Heis and Weber (H. 4, 5, 7, 11, 16, 20, 33, 37, 39, 44, 46, 53, 57); also by Brorsen, Schmidt, and Groneman (H. 15, 27, 58). Neumayer's remark, that the southern boundary is determined with difficulty (H. 32), derives special interest from his southern station, where this boundary is the upper one. Jones has a few similar observations in the southern hemisphere (Jj. 568, 572, 586, 618), relating chiefly to the "Stronger" Light. He occasionally found the "Diffuse" Light ill defined on its lower side (Jj. 290, 330, 352). Heis, on some occasions (H. 22, 23), found that the usual comparative sharpness of the lower boundary was wanting. Lewis states as a general rule that the southern side is more sharply defined and more nearly parallel with the ecliptic (Ls. 438). He adds the interesting remark that the axis of greatest brightness lies south of the axis of symmetry. It is obvious that the increase of atmospheric absorption with zenith distance will accelerate the diminution of light near the lower side, and retard it on the other, which must have some effect in making it easier to define the lower boundary, although we could not be confident, without the support of direct observation, that the effect would be considerable enough to attract attention.

A few additional results from the tables of the Appendix acquire some significance on the hypothesis that atmospheric absorption seriously affects the observed position of the zodiacal light, but are hardly to be regarded as strengthening that hypothesis, which must rest, for the present, on the facts already set forth. The change in the "latitude of the axis" consequent upon an increase of 30° in elongation is here called "displacement," for the sake of brevity, and is considered positive when the north "latitude of the axis" increases with the elongation. This displacement has been computed only for those observations in which the position of the light was determined at each of two elongations. The number of these observations is often too small for any conclusive result, and possibly they are not worth study. But those of Jones, Heis, and Weber seem to me to be numerous enough to deserve attention. The result I find from them is that the axis of the cone, as a rule, leans towards the ecliptic, so that its latitude, whether north or south, will be numerically less near the vertex than near the base. Supposing this to be an effect of atmospheric absorption, it appears that the increased brightness of the light at the smaller elongations does not fully counterbalance the increased tendency to a variation in latitude due to the increased difference in atmospheric absorption nearer the horizon. This seems antecedently probable, and indeed it may surprise us that we do not find much greater variations in latitude at small elongations. In Table II., for example, we have differences of absorption for the opposite boundaries of the "Diffuse" Light, at the elongation 60°, amounting to two or three entire magnitudes at the extreme inclinations of the ecliptic. These differences would doubtless be lessened by a strict computation, in which the position of the ecliptic would be computed separately for the same observations employed to determine the place of the light in latitude, instead of being found only for the mean of all the observations belonging to the group including them. However, in any case, the resulting differences of absorption would be large; and this would likewise be true of similar differences computed at the elongation 30°, either for the "Stronger" Light of Jones, or for the ordinary zodiacal light of other observers. Another circumstance which may seem inconsistent with the theory here advanced is, that when we compare the results at the same elongation (60°) for the "Stronger" Light in Table I. with those for the "Diffuse" Light in Table II., we find that a much smaller difference of absorption in the first case appears to produce nearly as much change of latitude. Still, the change is actually greater in the second case, and we have as yet no means of determining its theoretical value in any instance. A light which is actually confined to the zodiacal region cannot be shifted out of it by any amount of atmospheric absorption, although it may be so far diminished as to cease to be perceptible. Again, we cannot be sure, as has been said, that observers intend to signify equality of brightness on opposite sides by the location of their assumed boundaries. If the sky beyond the boundary is as much darkened as the sky within it, which may happen in the absence of haze and of artificial light in the neighborhood, the boundary might still be perceptible. Probably the condition of equality of light on the opposite sides is partially, though unconsciously, recognized in the effort to fix the boundaries, while at the same time it is not regarded as essential, especially when the boundaries are so far apart as those of the "Diffuse" Light at moderate elongations.

If atmospheric absorption has the importance here assigned to it in the study of the zodiacal light, we cannot expect to determine the true position of the light on any occasion by the simple methods heretofore in use. We must either discover exactly what an observer means by the boundary, and to what extent this boundary will be displaced by given changes of brightness, or we must resort to direct photometric observations. The last course will probably be preferable. In the absence of instruments, observers must not content themselves with the casual comparisons heretofore made, but must compare together different portions of the light, and also specified portions of the light and of the Milky Way. The Milky Way itself must be studied in a similar manner to learn the corrections for absorption due to the varying altitude of its separate parts. Observations of this kind, it is to be apprehended, cannot be made to advantage except in situations peculiarly favorable to uniform transparency of the atmosphere at all azimuths, and remote from large towns, in order to avoid the disturbing effect of artificial light.

Perhaps some photometric apparatus may be contrived to make these determinations more generally practicable. Argelander's proposal (A. 157) to compare a portion of the zodiacal light seen with one eye and a star seen out of focus with the other, may at least furnish a suggestion for a photometer of the required kind, if it should prove inapplicable in its original form. Wolf's method (W. 32) of tracing the limits of the nebulosity about the Pleiades may likewise prove serviceable in observations of the zodiacal light. It consisted in watching the fine threads of a reticule, which became visible against the nebulosity, but disappeared when the telescope was directed to the darker sky beyond. Suppose a telescope to be provided with a series of suitable reticules, and also with some apparatus for diminishing the aperture or otherwise darkening the field. One of the most promising methods of accomplishing this object is that employed by Loewy (L. 92). A diaphragm having a circular aperture is made to slide along the tube of the telescope, and its position is recorded by means of a scale attached to the outside of the tube. If the reticules to be used are of successive degrees of fineness, so that each will be as visible with a small aperture as the next in order is with a large aperture against the same background, an extensive range of comparisons would be practicable. The same apparatus might be employed in comparing the images of stars thrown out of focus to a known extent, and a standard of comparison for faint lights might thus be established. But much experience would be needed to test the value of a photometer of this description.

Any considerable series of photometric observations of the zodiacal light, made with trustworthy apparatus and upon a suitable system, would doubtless furnish better means of determining the real position of the light with regard to the ecliptic than could be provided by the most voluminous collection of sketches. We should thus acquire some reliable information about the inclination and nodes of the great circle representing the axis of the light, which has hitherto been sought with little success. But our work, to be complete, must include an inquiry into the normal distribution of light in the sky. The zodiacal light is seen upon a background by no means of uniform brightness, even in regions remote from the Milky Way. Its more brilliant portions, very probably, may not be sensibly affected by the inequalities of the background, but its edges, and especially its vertex, cannot be determined without attention to these inequalities. The interest of a careful photometric inquiry into the relative light of different parts of the sky, and especially into the exact form of the Milky Way, would be considerable, even without reference to its bearing upon the question of the zodiacal light. But the inquiry is indispensable if we are to substitute definite knowledge for the vague information now before us with regard to "zodiacal bands," the singular phenomenon of "Gegenschein," and the possibly periodical variations in the main body of the zodiacal light, as well as its apparent changes from hour to hour.

As a first instance, let us consider the semiannual variation in the elongation of the vertex, evidence of which Serpieri has obtained from the observations of Jones (Sp. 99), confirming the result by similar data from the work of Heis (Sp. 101, H. 60). A comparison of the mean elongations for the successive months given by Serpieri, from his reduction of the work of Jones, with the corresponding series in Table XIII. of the Appendix, shows a sufficient general agreement, although there was a considerable difference between the two methods of reduction, and even in the processes by which the separate elongations were derived from the observer's charts (Sp. 62).

In both cases, we have two yearly maxima of elongation (about the beginning and middle of each calendar year) with a tolerably regular diminution and increase from each maximum to the next. The "Stronger" Light, however, shows no maximum for the evening observations of the beginning of 1854, nor, according to Serpieri, for the morning observations of the middle of 1853.

Before concluding that these variations indicate any important annual series of changes in the zodiacal light itself, we must examine the circumstances under which the observations are necessarily made. An inspection of the charts shows us that the maxima occur at those times of year when the Milky Way cannot interfere with the observations. This is true of the eastern, as well as of the western light. We cannot very confidently assume that the interference of the Milky Way is the cause of the observed lessening in the elongations attained at other times. If it is, we must infer that, when the Milky Way intersects the zodiacal light, its brightness prevents the observer from tracing the light so far beyond it as he might in the absence of its disturbing influence. It is probable that the question must be left to the decision of photometric observations.

We may next consider the fact, hitherto resting solely on the evidence of Jones, that the apparent elongation of the zodiacal light extends as the evening advances. Most observers have contented themselves with a single drawing of the light for each date of observation, so that they give us no aid in the decision of the question. But it is highly probable that the common statements with regard to the rising and setting of the zodiacal light cannot be accepted without modification. The testimony of one industrious observer to a multitude of particular facts must ordinarily prevail over mere general assertions. Jones paid special attention at times to the mode in which the light disappeared, with varying results (Jj. 186, 190, 192, 196, 248). The darkness of the sky which he observed near the horizon, in the same stellar region where the light had been seen earlier in the evening, is certainly not conclusive, for ordinary atmospheric absorption may have produced it. On the whole, I should infer from these passages that the final disappearance of the light occurs by its setting, rather than by its fading. But this does not change the customary result, apparent everywhere in the work of Jones, that long after ordinary twilight has ended the zodiacal light continues to extend itself towards the east, contrary to the diurnal motion of the stars. I have myself noticed this phenomenon at different times, but only casually, and on occasions when no leisure for a precise record of it could be obtained. The vertex of the light seems to remain at the same altitude for a long time. Serpieri thinks that this and other results of the observations of Jones require us to abandon all purely cosmical theories of the zodiacal light, and oblige us to consider it as a terrestrial phenomenon (Sp. 73, 152). But it seems to me that before coming to this conclusion we must know more of the nature of twilight than we do now. We need to know whether the sky is really as dark just after the arch of distinct twilight has disappeared as it is some hours later. General impressions and theories upon the subject should be replaced by accurate observations. If the sky grows sensibly darker for a long time after twilight, the zodiacal light may of course become more apparent during this time. Moreover, the increase of sensitiveness in the observer's eye during the evening may be more gradual than would at first be supposed.

The next class of phenomena to be discussed is that comprising the " zodiacal bands " reported by different observers. The wide zodiacal band seen by Jones at Quito (Jq. 376) need not here be considered. It is to be hoped that some equally enterprising observer will undertake the re-examination of the subject under similarly favorable conditions. At the present time, the Andes are occasionally visited by amateur mountaineers who have exhausted the Alps, and perhaps they will yet furnish us with a continuation of the interesting work which Jones considered to be in itself a sufficient object for the journey. Although he thought that traces of the band he had seen at Quito were afterwards perceptible from less advantageous stations (Jq. 378), it is certain that very few observers have seen anything approaching it in width, distinctuess, and definite position in the zodiac; and it is still to be determined whether it may not have been the effect of local or temporary causes.

The zodiacal bands more ordinarily seen have seldom been described with the exactness requisite for making satisfactory comparisons between the reports of different observers. The account given by Lewis (Ls. 441) resembles that given by Jones of his Quito observations in many important particulars. The additional facts furnished by Lewis, that the band he saw was " more sharply defined on its southern than on its northern edge," and that, " while its axis of greatest brightness is either on or very slightly north of the ecliptic, the axis of symmetry is decidedly north of that line," apparently indicate effects of atmospheric absorption. If these observations can be confirmed by others, they will have laid the foundation of an important addition to our knowledge.

So far as I have learned, only one zodiacal band has been so repeatedly and definitely described as to leave no doubt of its existence. This is a faint and narrow belt which takes a southwesterly course from the Pleiades, or rather perhaps from a place on the southern border of that group. In the Astronomische Nachrichten, XCIX. 91, 369, will be found a statement of some reasons for thinking that this band should rather be considered as a branch of the Milky Way than as especially zodiacal in its character. I am unable to trace it through Aquarius into Capricornus. The darkness of Capricornus may certainly be due to atmospheric absorption, and observations at a more southern station are needed to decide the question. But the band, as I see it, does not terminate in Aquarius; it is continued to Aquila, quitting the zodiac altogether. This circumstance, combined with the evidence furnished by the Durchmusterung of a slight maximum of stellar density along the northern portion of the band, induces me to regard it as a sidereal and not as a zodiacal phenomenon.

The earliest account of the zodiacal portion of this band, so far as I know, was given by Schmidt, who repeatedly observed it (S. 26, 29, 32, 33, 35, 36, 44, 49, 50, 51). The definite observation of November 11, 1849 (S. 36), has a particular interest. But it can scarcely be doubted that many of the other observations refer to the same object. On October 24, 1853, the observer noticed the extension of this band into the region of $\alpha$ and $\beta$ Aquarii (S. 44). Schmidt was in doubt about the conclusion to be drawn from these observations (S. 68), which may indicate that the explanation of them by a stream of stars had suggested itself to him; but he does not propose that hypothesis. It seems likely that his perception of the luminous band under discussion had an influence upon many of his drawings of the ordinary zodiacal light, which may partially account for the peculiarities already mentioned (p. 152).

Brorsen appears to describe this band as visible early in December, 1853 (H. 12). Later in the month, the advance of the ordinary zodiacal light tended to make it a less definite object. Groneman (H. 55) likewise describes a similar appearance on December 2, 1874. The observation made at Toulouse on November 10, 1874 (T. 1251), may perhaps relate to the same class of phenomena. Any observation of light between the Pleiades and the Milky Way, however, needs to be carefully verified by comparisons made on other occasions, for certainly there is much galactic light in that region. The prolongation beyond the Pleiades towards the southwest may belong to the band already considered. There seems to me to be an extension of the Milky Way on the opposite or eastern side, passing through and beyond Præsepe (Astr. Nachr., CII. 263), which may have had something to do with the Toulouse observation. Jones noticed this band, or part of it, on February 15, 1854 (Jj. 234). The narrow band from the Pleiades did not attract his attention, unless we suppose that it was in part the cause of the maximum of elongation which occurs, as we have seen (p. 162), about the beginning of the year. But the zodiacal light, as observed by Jones, is too wide to be readily connected with a band only about five degrees in width, and, moreover, we might expect the maximum of elongation, if due to the perception of this band, to show itself earlier in the season. This is actually the case in the observations of Dechevrens (D. 20), who frequently noticed the band as an extension of the zodiacal light (D. 5, 10). It is natural that observers should not usually become aware of this faint object until the season of the year when it has been reached by the vertex of the ordinary zodiacal cone. In endeavoring to find the vertex, the eye then follows the previously unnoticed band as far as the Pleiades, without reaching any place at which the light can be said to terminate.

Before we can satisfy ourselves with regard to the true zodiacal bands, as they may be called, which are described by Jones and Lewis, it is necessary for us to observe accurately the extent and brightness of the similar phenomena which have just been considered. Moreover, our observations ought not to be confined to the zodiac, for, if they are, we may overlook the existence of bands of light intersecting it at considerable angles, the zodiacal portions of which may occasion perplexities in our subsequent work. The need of general knowledge with respect to the normal distribution of light in the sky thus becomes evident, even if we seek only a thorough knowledge of zodiacal phenomena.

Admitting the occurrence of the phenomenon called "Gegenschein," which certainly has a large mass of evidence in its favor, we must still feel much uncertainty about its visibility on particular occasions, until we are able to say with some confidence that the light we are observing is greater than the normal light of the region in which it appears. At present, we have only our memory of former observations to prevent mistakes, and if the observer feels sure of the correctness of his own memory, he ought to have some surer means of making the facts of the case clear to others who have not witnessed them. For the study of all zodiacal phenomena, therefore, a photometric survey of the sky is urgently required.

Although the opinion of Serpieri, that the zodiacal light is a species of aurora (Sp. 153), will probably not find general acceptance in the present state of our knowledge, it is likely that auroral and zodiacal light may sometimes be confounded with each other. Auroral bands sometimes occur, as is well known, in the form of arches extending from the eastern to the western horizon, and retaining their form and place for a considerable time. It is possible that such arches are formed at times in the absence of any other auroral light. If this should happen at a time when the azimuth of the pole of the ecliptic is approximately equal to the magnetic declination, we might have an auroral band along the zodiac which would be taken for zodiacal light. It is mainly for this reason that it has seemed desirable to provide in the Appendix for approximate determinations of the azimuth of the pole of the ecliptic.

Eylert's observations of December 8 and 9, 1873 (H. 49, 50), afford instances where the presence of auroral light may be suspected. On these dates he saw a luminous arch crossing the heavens, the western part of which had the customary form and position of zodiacal light; but the eastern part made an angle of about 17° with the ecliptic, from which it deviated to the southeast. The observer was in latitude about +20°, longitude about 30° west of Greenwich, where the magnetic declination is about 15° west. The azimuth of the north pole of the ecliptic was about 23° west of north, and its zenith distance about 76° for the mean of the two observations. It follows that the aberrant portion of the zodiacal light was more nearly perpendicular to the magnetic meridian than to the circles of latitude, but the deviation was in excess of what would be required on the hypothesis that an auroral band was seen. It may not be always the case that these auroral bands are perpendicular to the magnetic meridian, and the evidence of auroral light in this instance is not at all conclusive.

A few days later, on the evening of December 12, 1873, Serpieri, at Urbino in Italy, observed a general illumination of the zodiac (H. 51). The occurrence of coruscations in the light on this occasion perhaps adds a little weight to the suspicion of auroral action, but these coruscations, or pulsations, as Jones called them, have often been seen in the zodiacal light proper. The nature of this phenomenon, also, evidently requires photometric investigation. On the evening of January 31, 1883, I found, during half an hour's observation, that there were apparent variations in the relative brightness of definite portions of the zodiacal light with respect to definite portions of the Milky Way. But the variation may not have been real, or it may possibly have been due to variable haze, too indefinite in outline to be recognized.

It is not my intention, on this occasion, to discuss the probability of any explanation of the zodiacal light. I have merely to remark, with regard to the ordinary meteoric theory, that it gains greatly in simplicity if we dispense with all the imaginary meteoric bodies or rings with which it has usually been connected. and retain merely the conception of meteoric dust diffused throughout the Solar System. It may be shown mathematically, if we regard the meteoric particles as solids, reflecting light irregularly, that an appearance like the zodiacal cone, with an indefinite vertex, would result. On this subject, the work of Geelmuyden may be consulted (G. 95, 106).

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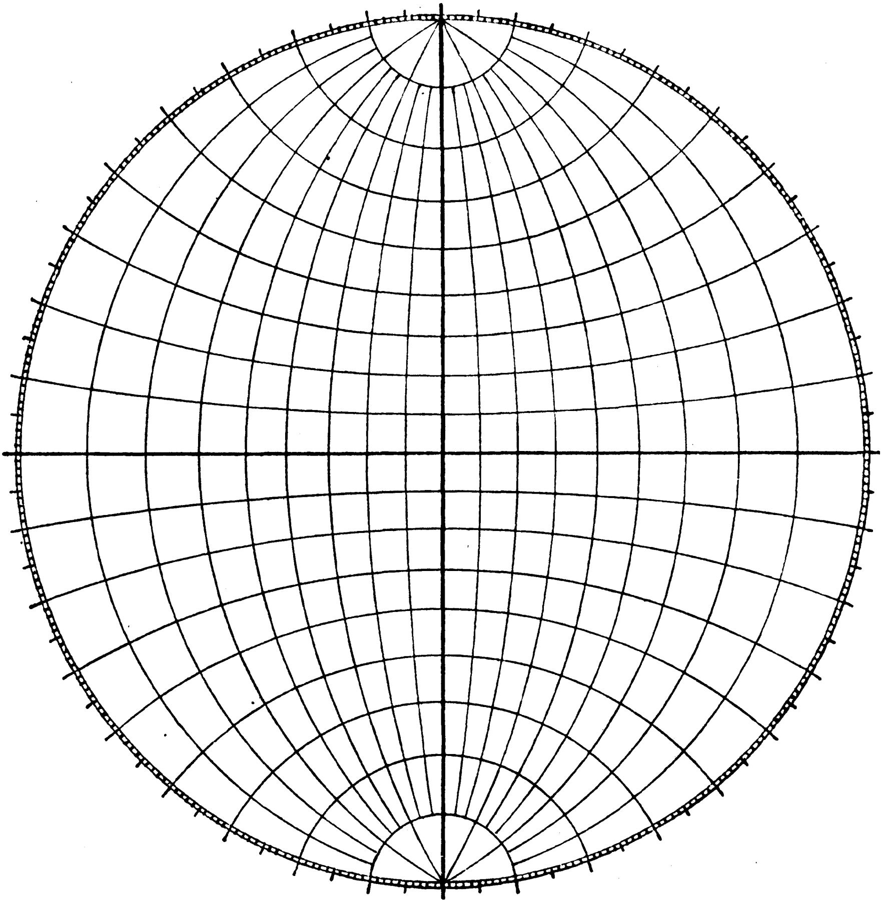
# APPENDIX.

In passing from one system of spherical co-ordinates to another, an approximate result is sometimes all that is required. This is usually the case when the zodiacal light is the subject under consideration, and occasionally happens in the course of other inquiries; for example, during the computation of differential refraction, or when it is desirable to know that no gross error has occurred in the computation of an exact position. For all such purposes, the projection of a hemisphere with the poles upon the circumference is a convenient resource. A stereographic projection, like that given in the annexed figure, has the advantage of being very easily constructed, at least when the scale is small, but any circular and symmetrical chart of a hemisphere will suffice. It is needless to state the principles of this method of changing co-ordinates, but a few illustrations of its use may be serviceable. In the following directions, a piece of tracing paper is supposed to be at hand, but it may obviously be replaced by measurements from the centre and from the proper points on the circumference of the chart. Although the figure here given is a somewhat distorted copy of the drawing which it represents, it will probably be found sufficiently accurate to be of some use.

In discussing observations of the zodiacal light, we may require the zenith distances, and perhaps the azimuths of a number of points the latitudes and longitudes of which are known, while we also have the latitude and longitude of the zenith, and the azimuth of one pole of the ecliptic. In this case, consider the circumference of the projection as representing the circle of latitude passing through the zenith. Begin by regarding the chart as one exhibiting latitudes and longitudes. Mark the centre of the projection upon the tracing paper, and lay down the place of the zenith, by means of its latitude, upon either side of the circumference, as may be preferred. Knowing the longitude of the zenith, we can also lay down the place of the Sun and those of the required points, or we can make a sketch of the zodiacal light as defined by elongation and latitude. Then turn the paper so that



the point marked as the zenith may coincide with the proper pole of the projection, keeping the point marked as the centre in position. The co-ordinates of the chart will now be altitude and azimuth, in terms of which we may read off the new positions of the points previously laid down in latitude and longitude. The origin of the azimuth readings is to be obtained from the known azimuth of the pole of the ecliptic. It will rarely happen that any of the required points will lie in the hemisphere opposite to that supposed to be exhibited on the chart, but if this should be the case, these points can be laid down as easily as the others, from which they may be distinguished by a special form of marking, in order to prevent errors in reading their co-ordinates after the paper has been turned.

If we desire to convert right ascensions and declinations into equivalent positions in latitude and longitude, we regard the circumference of the projection as the solstitial colure. After marking the required points upon the tracing paper, we turn it through an angle equal to the obliquity of the ecliptic, and read off the new positions of the marks. As the right ascension and declination of the zenith are known from the sidereal time and terrestrial latitude, this method may be used to obtain the celestial latitude and longitude of the zenith, which were supposed to be known in the former example. If the azimuth of the pole of the ecliptic is required, we may suppose the circumference of the projection to represent the meridian, lay down the pole of the ecliptic on the tracing paper, and turn it through an angle equal to the complement of the terrestrial latitude. But the relative positions of the zenith and ecliptic may generally be found still more readily from the tables given below, with sufficient accuracy for many purposes.

The chart may be used conveniently for determining zenith distances and parallactic angles in a given terrestrial latitude by first drawing the given parallel of latitude on the tracing paper, marking its intersections with the meridians, and numbering these intersections. The centre of the projection, and the pole, are likewise to be marked, as in other cases. If the circumference of the projection is then regarded as the circle of declination passing through a known star, we may set the point marked as the pole to the place of this star, read its hour angle along the traced parallel of latitude, and the corresponding zenith distance and parallactic angle by the co-ordinates of the chart at the point of the parallel thus determined. The azimuth of the star may then be found, if desired, by supposing the triangle inverted, so that the zenith distance will be read along the circumference. After turning the paper to the corresponding position, the azimuth can be read off on the traced parallel.

In general, a chart of this form may be used for the solution of any spherical triangle, two sides of which, with the included angle, are given. The drawing might be constructed on a scale large enough to read tenths of a degree with considerable accuracy, and a sheet of slightly ground glass or of transparent parchment might be permanently centred over it to make its use more expeditious and precise. It may sometimes be worth while to take the mean of results obtained in different quadrants. With the help of two traced parallels, indicating respectively the declinations of the pole of the ecliptic and of the zenith, the chart may be applied to the solution of various problems in which the three sides of a triangle are known.

The time of an observation of the zodiacal light is seldom recorded with precision. Even if it were possible to fix the time of such an observation accurately, there is as yet no apparent advantage in attempting to do so, except when rapid changes seem to be occurring in the brightness and extent of the light. It is consequently superfluous to make any exact determination of the position of the ecliptic in the visible hemisphere at the time of each observation. In such computations of the kind as are required, we may disregard the changes in the relation between mean and sidereal time, at given dates and places, due to the occurrence of leap year, to the gain of the sidereal clock during a single day, and to the longitude of the observer. Tables III. to IX. inclusive (pp. 179–184) give the approximate position of the ecliptic for any date and any mean time. They have been employed in the formation of the subsequent tables, but are given here in a modified form for the sake of convenience in printing, which may occasionally make a slight change in single results derived from them. Table III. gives the approximate longitude of the Sun for the first day of each month, and the hour angle of the north pole of the ecliptic for each hour of mean time on the same days. This hour angle is counted towards the west, from 0° to 360°. Interpolation in this table is effected without trouble by allowing one degree a day for a change in date, and fifteen degrees an hour for a change in time. With the hour angle thus obtained for one argument, and the latitude of the observer's station for another, Tables IV. to IX. inclusive give the zenith distance of the north pole of the ecliptic, the azimuth of the same pole, counted from north to west and from 0° to 360°, and the longitude of the zenith. Each of these tables is divided into two parts by a heavy rule between the latitudes 60° and 70°, to show that interpolation is subject to some inconvenience at these places, on account of the passage of the pole of the ecliptic. This part of the tables, however, will seldom be consulted in any use to which they are put, and probably never in discussing observations of the zodiacal light. From the longitude of the zenith derived from these tables, the longitude of the Sun (from Table III.) is to be subtracted when the "elongation of the zenith" is required for an evening observation.

Table X. contains the results of measurements made upon the charts representing the evening observations published by Jones in his large work referred to in the preceding discussion as "Jj." The numbers in the first column refer to the charts employed. The date in the second column, and the latitude in the fourth, are also taken from Jones, south latitudes being here expressed in Italic figures. The longitude of the Sun in the third column, and the quantity *t* in the fifth (*t* signifying the hour angle of the north pole of the ecliptic), are taken from Table III., with the aid of the times of observation recorded by Jones, which can accordingly be approximately reproduced by means of Table III., in case they are desired by any reader who cannot consult the original work. These data are followed by two columns giving the respective elongations of the vertices of the "Stronger" and "Diffuse" Lights observed by Jones. These elongations were measured from the place of the Sun as given on most of the observer's published charts. In some cases, this place falls beyond the limits of the chart, and Jones then adds a note giving the longitude of the Sun which was employed in the measurement. The next six columns contain the north and south latitudes of the boundary of the "Stronger" Light at the respective elongations 30°, 60°, and 90°. These elongations were found upon the charts in the same way as those of the vertex. When the northern boundary lies south of the ecliptic, or the southern boundary north, the measured latitude is regarded as negative, and is expressed in Italic figures, which are used throughout these tables as a substitute for the negative sign. The last six columns give the corresponding figures for the "Diffuse" Light at the elongations 60°, 90°, and 120°. All the measurements made upon the charts were merely approximate, and they have not, in general, been revised. They are believed, however, to have been made with sufficient care for the purpose in view. When the boundaries drawn upon the chart terminated near the longitude at which the measurement was to be made, they were occasionally extended by estimate in order to obtain a latitude, but the number of these estimates forms a very small proportion of the entire number of entries. When an unusually large number of observations were made upon a single evening (as on occasions when "pulsations" in the light were noticed), some of them are often omitted in Table X. A few accidental omissions may also have occurred.

Table XI. contains results similar to those of Table X., taken from the Zodiacallicht-Beobachtungen of Heis, to which reference is made in the preceding discussion by the letter H. The first column of Table XI. contains a continuous series of numbers, not taken from Heis, but inserted here for convenience of reference. The second column gives the name of the observer, and the third the date. The next three columns give the longitude of the Sun, the latitude of the observer, and the hour angle of the north pole of the ecliptic, denoted by *t*, as in Table X., and found in the same manner. These columns are followed by the elongation of the vertex, which is occasionally given by Heis in half-degrees, but here expressed in whole degrees only. The last six columns give the latitudes of the northern and southern boundaries at the elongations 30°, 60°, and 90°, as in the case of the "Stronger" Light of Jones. In the work of Heis, the latitudes of the northern and southern boundaries are given at intervals of 10° in longitude. The longitude of the vertex, as well as its elongation, is also given. From these data the latitudes of Table XI. have been obtained by estimate. Negative quantities are expressed by Italic figures, as already explained in the description of Table X.

Table XII. contains results derived from Schmidt's work, "Das Zodiacallicht," designated as "S" in the preceding discussion. The observations are here arranged in the order of the seasons, as they were placed by Schmidt on pages 55–61 of his work. Besides the observations there given, five others, made Dec. 1–20, have been collected from the previous pages. Schmidt seems to regard them as too uncertain to be worth reduction (S. 54, 68), but it has been shown above (p. 165) that they probably have a distinct meaning.

The first three columns of Table XII. contain a number for reference, the date of the observation, and the latitude of the observer's station. The next four columns give the zenith distance of the north pole of the ecliptic (here called the inclination of the ecliptic for the sake of brevity), the azimuth of the north pole of the ecliptic, the longitude of the Sun, and the elongation of the zenith, all derived from Tables III. to IX. inclusive. The last ten columns give the north and south latitudes of the boundary of the light for the elongations 30°, 60°, 90, 120°, and 150°. They are derived from Schmidt's data on pages 55–61 of his work, except that for the first five observations a separate reduction was necessary. This was effected by means of a chart like that just explained (p. 168).

Tables XIII. to XVIII. inclusive contain monthly means derived from Table X. In order to facilitate any grouping of the months which may appear desirable, the sums of the readings have generally been retained in these tables, the form of which, in other respects, has been largely determined by considerations of convenience in printing. Table XIII. gives the names of the successive months during which Jones carried on his work, preceded by a column of numbers for reference, which is repeated in the subsequent tables without the names of the corresponding months. The third column of Table XIII. gives the number of evenings in each month on which the observations collected in Table X. were made, and in the fourth column are entered the corresponding total numbers of observations. The fifth column gives the mean result for the observer's latitude, expressed in whole degrees. The next two columns contain the inclination of the ecliptic and the azimuth of its north pole, as in the corresponding columns of Table XII. Instead, however, of finding these quantities for each separate observation and taking their means, it was considered sufficient to take the monthly means of the quantities in column *t* of Table X., and to combine the result with the mean latitude. The mean of the longitudes of the Sun for each month is given in the next column, and this is followed by the elongation of the zenith, the longitude of which was first found from the mean values of *t* and the observer's latitude, as just explained. The last six columns of Table XIII. give the mean elongations of the vertices of the "Stronger" and "Diffuse" Lights, preceded by the numbers of observations and the sums from which the means were derived.

Tables XIV. and XV. give in like manner, for the "Stronger" and "Diffuse" Lights respectively, the mean latitudes of their northern and southern boundaries at the various elongations included in Table X., with the numbers and sums used in obtaining the means.

Tables XVI. and XVII. give mean results at the same elongations for the "latitude of the axis" (as we may call the mean of the latitudes of the northern and southern boundaries), and for half the extent of the light in latitude (the "halbe Dicke" of Schmidt). Italic figures here indicate south latitudes. In obtaining these results, only those observations of Table X. were employed in which both the northern and the southern boundaries had been observed at the required elongations. The results accordingly differ to some extent from those which would be obtained by the combination of the mean results given in Tables XIV. and XV.

Table XVIII. gives the mean results for the changes produced in the "latitude of the axis" and the "half extent in latitude" just explained, by an increase of thirty degrees in the elongation. Here also only those observations have been used which afforded complete determinations, and the results will differ from those directly obtainable by comparison of the quantities found in Tables XVI. and XVII. This restriction of the observations, of course, often makes the number which can be used too small to permit any inference from the result until it has been combined with others to form a larger group. The data of Table XVIII. are given under the headings "Displacement" and "Contraction," respectively, for stated changes of elongation. Under "Displacement," the negative results expressed by Italic figures indicate that the axis lies farther south at the greater elongation. Under "Contraction," the diminution of the "half extent in latitude" is expressed as a positive quantity, and a negative result would mean that this extent increased, instead of diminishing, with the elongation.

In discussing the observations of Table XI., those made by Eylert and by Neumayer, owing to their small number, can be reduced separately with little trouble. It seemed best, however, to furnish an intermediate step in the reduction of those made by Heis and Weber, (as has already been done for those of Jones by Tables XIII. to XVIII. inclusive). They have accordingly been arranged according to the calendar months, and the mean results thus obtained are given in Tables XIX. to XXII. inclusive. The form of Table XIX. is nearly the same as that of Table XIII. As only one observation was made on a single day, the column "No. of Days" is omitted; and the column of months does not proceed in chronological order, as in Table XIII., but combines the observations of different years. Since Heis and Weber sometimes observed an "inner cone," the mean elongation of its vertex is here given in a space which would otherwise be vacant; the separate observations are too few to require a place in Table XI. Table XX. gives for Heis and Weber results corresponding to those of Tables XIV. and XV. for Jones. Tables XXI. and XXII. in like manner correspond to Tables XVI., XVII., and XVIII., with one difference. From the form in which Heis gives the observations, it is sometimes practicable to find the latitude of the axis at elongations for which the latitudes of the boundaries cannot so well be estimated. This allows the number of observations of the axis, in Table XXI., occasionally to exceed that of the observations of "half extent." Similarly, in Table XXII., the numbers for "Displacement" and for "Contraction" sometimes differ, and are therefore given in separate columns, instead of together, as in Table XVIII.

The remaining tables exhibit a grouping of the observations according to the principle announced by Jones that the position of the zodiacal light in latitude differs according to the inclination of the ecliptic, as it has been called in the previous tables; that is, according to the zenith distance of the north pole of the ecliptic. Tables XXIII. to XXVI. inclusive arrange the results here obtained for the work of Jones in seven groups defined as follows: Group 1 includes the observations of 1853, June, July, August, and September; and of 1854, May, June, July, September, and October. Group 2 includes 1853, October, and 1854, August and November. Group 3 includes 1854, April and December. Group 4 includes 1853, November and December; 1854, February and March; 1855, April. Group 5 includes 1853, April, and 1854, January. Group 6 includes only 1855, January, and Group 7, 1855, February and March. The numbers of these groups are given in the first column of each table from XXIII. to XXVI. inclusive. In Table XXIII. the second and third columns give the mean inclination of the ecliptic and elongation of the zenith derived from Table XIII., allowing equal weight to all the separate observations, so that the weight allowed to the result for each month is proportional to the number of observations for that month. The next two columns give the number of observations of the elongation of the vertex of the "Stronger" Light, with the mean result, allowing all observations equal weight, as before. The remainder of the table contains the mean results for the latitude of the boundaries of the "Stronger" Light, with the number of observations on which each depends, collected from Table XIV.

Table XXIV. contains similar data for the "Diffuse" Light, from Tables XIII. and XV. In the second and third columns, instead of repeating the inclination and elongation already given in Table XXIII., it appeared more convenient to insert the mean latitude of the observer, and the zenith distance of the Sun, this last being derived from the data of Table XXIII. by means of a chart.

Tables XXV. and XXVI. give for each of the seven groups, and for the "Stronger" and "Diffuse" Lights respectively, the number of observations and the mean result for "latitude of axis," "half extent in latitude," "displacement," and "contraction," as already explained. These quantities are obtained from Tables XVI.,.XVII., and XVIII.

Tables XXVII. and XXVIII. contain a similar series of results for the work of Heis and Weber. The groups, for Heis, are as follows: Group 1, May, November, December; Group 2, January, April; Group 3, February, March. The two observations, one in

July and one in August, are here neglected. For Weber, Group 1 comprises May and December; Group 2, January and April; Group 3, February and March. The form of Table XXVII. is the same as that of Table XXIII.; while Table XXVIII. resembles Table XXV., but gives the number of observations separately for "axis" and "extent," for "displacement" and "contraction." The reason for this has already been given in describing Tables XXI. and XXII.

Tables XXIX. to XXXII. inclusive refer to the observations of Eylert and Neumayer, combined in a single grouping, since Neumayer's four observations are not sufficient for a separate discussion. The groups are as follows: Group 1 contains the observations numbered 273, 274, 290, 291, 292, in Table XI.; Group 2 contains Nos. 287, 288, 289; Group 3, Nos. 275, 276, 277, 285, 286, 295, 296; Group 4, Nos. 278 to 284 inclusive, and Nos. 293, 294. The form of Table XXIX. agrees with that of Table XXIII. Table XXX. contains a few means from observations not detailed in Table XI. for want of space. These include four observations of the elongation of the vertex of an "inner cone," and four observations of the boundaries at elongations greater than 90°. The second and third columns of Table XXX. are filled by the latitude of the observer according to the mean of all the observations belonging to the group, and by the zenith distance of the Sun from the data in the second and third columns of Table XXIX. The form of Table XXXI. is that of Table XXV., and Table XXXII. gives similar data for the observations at extreme elongations just mentioned.

In Tables XXXIII. and XXXIV. the observations of Table XII. are grouped as follows: Group 1 contains Nos. 1, 2, 8, 11; Group 2, Nos. 3, 4, 5, 6, 7, 9, 10, 12, 32, 33, 37; Group 3, Nos. 13 to 25 inclusive, and Nos. 28, 36; Group 4, Nos. 26, 27, 29, 30, 31, 34, 35. Table XXXIII. has nearly the form of Table XXIII., with the addition of a section for observations at the elongation 120°. The second and fifth columns give the latitude of the observer and the zenith distance of the Sun; while the third and fourth give the inclination of the ecliptic and the elongation of the zenith. Table XXXIV. gives data corresponding to those of Table XXV., but extending, as in Table XXXIII., to the elongation 120°.

Table XXXV. gives the relative amount of atmospheric absorption, expressed in terms of stellar magnitude, for different zenith distances. It is derived from Müller's table (p. 59 of his Photometrische Untersuchungen). At zenith distances less than 17°, the absorption is less than five thousandths of a magnitude in excess of its value at the zenith.

## TABLE III. — HOUR ANGLE OF NORTH POLE OF ECLIPTIC.

| Date. | Jan. 1 | Feb. 1 | Mar. 1 | April 1 | May 1 | June 1 | July 1 | Aug. 1 | Sept 1 | Oct. 1 | Nov. 1 | Dec. 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Long. of Sun. | 281° | 312° | 340° | 11° | 40° | 70° | 99° | 129° | 158° | 188° | 219° | 249° |
| Mean Time. h | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 0 | 11 | 41 | 69 | 100 | 129 | 160 | 190 | 220 | 251 | 280 | 311 | 340 |
| 1 | 26 | 56 | 84 | 115 | 144 | 175 | 205 | 235 | 266 | 295 | 326 | 355 |
| 2 | 41 | 71 | 99 | 130 | 159 | 190 | 220 | 250 | 281 | 310 | 341 | 10 |
| 3 | 56 | 86 | 114 | 145 | 174 | 205 | 235 | 265 | 296 | 325 | 356 | 25 |
| 4 | 71 | 101 | 129 | 160 | 189 | 220 | 250 | 280 | 311 | 340 | 11 | 40 |
| 5 | 86 | 116 | 144 | 175 | 204 | 235 | 265 | 295 | 326 | 355 | 26 | 55 |
| 6 | 101 | 131 | 159 | 190 | 219 | 250 | 280 | 310 | 341 | 10 | 41 | 70 |
| 7 | 116 | 146 | 174 | 205 | 234 | 265 | 295 | 325 | 356 | 25 | 56 | 85 |
| 8 | 131 | 161 | 189 | 220 | 249 | 280 | 310 | 340 | 11 | 40 | 71 | 100 |
| 9 | 146 | 176 | 204 | 235 | 264 | 295 | 325 | 355 | 26 | 55 | 86 | 115 |
| 10 | 161 | 191 | 219 | 250 | 279 | 310 | 340 | 10 | 41 | 70 | 101 | 130 |
| 11 | 176 | 206 | 234 | 265 | 294 | 325 | 355 | 25 | 56 | 85 | 116 | 145 |
| 12 | 191 | 221 | 249 | 280 | 309 | 340 | 10 | 40 | 71 | 100 | 131 | 160 |
| 13 | 206 | 236 | 264 | 295 | 324 | 355 | 25 | 55 | 86 | 115 | 146 | 175 |
| 14 | 221 | 251 | 279 | 310 | 339 | 10 | 40 | 70 | 101 | 130 | 161 | 190 |
| 15 | 236 | 266 | 294 | 325 | 354 | 25 | 55 | 85 | 116 | 145 | 176 | 205 |
| 16 | 251 | 281 | 309 | 340 | 9 | 40 | 70 | 100 | 131 | 160 | 191 | 220 |
| 17 | 266 | 296 | 324 | 355 | 24 | 55 | 85 | 115 | 146 | 175 | 206 | 235 |
| 18 | 281 | 311 | 339 | 10 | 39 | 70 | 100 | 130 | 161 | 190 | 221 | 250 |
| 19 | 296 | 326 | 354 | 25 | 54 | 85 | 115 | 145 | 176 | 205 | 236 | 265 |
| 20 | 311 | 341 | 9 | 40 | 69 | 100 | 130 | 160 | 191 | 220 | 251 | 280 |
| 21 | 326 | 356 | 24 | 55 | 84 | 115 | 145 | 175 | 206 | 235 | 266 | 295 |
| 22 | 341 | 11 | 39 | 70 | 99 | 130 | 160 | 190 | 221 | 250 | 281 | 310 |
| 23 | 356 | 26 | 54 | 85 | 114 | 145 | 175 | 205 | 236 | 265 | 296 | 325 |

## TABLE IV. — ZENITH DISTANCE OF NORTH POLE OF ECLIPTIC.

For Stations in North Latitude.

| North lat. | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | North lat. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hour angle of north pole of ecliptic. 0° | 67° | 57° | 47° | 37° | 27° | 17° | 7° | 3° | 13° | 23° | 0° Hour angle of north pole of ecliptic. |
| 10 | 67 | 57 | 47 | 37 | 27 | 17 | 8 | 5 | 14 | 23 | 350 |
| 20 | 68 | 58 | 48 | 38 | 29 | 19 | 11 | 8 | 14 | 23 | 340 |
| 30 | 70 | 60 | 50 | 41 | 31 | 22 | 15 | 11 | 16 | 23 | 330 |
| 40 | 72 | 63 | 53 | 44 | 35 | 26 | 19 | 15 | 17 | 23 | 320 |
| 50 | 75 | 66 | 56 | 47 | 38 | 30 | 23 | 18 | 19 | 23 | 310 |
| 60 | 79 | 69 | 60 | 51 | 42 | 34 | 27 | 22 | 20 | 23 | 300 |
| 70 | 82 | 73 | 64 | 55 | 46 | 38 | 30 | 25 | 22 | 23 | 290 |
| 80 | 86 | 77 | 68 | 59 | 50 | 42 | 34 | 28 | 24 | 23 | 280 |
| 90 | 90 | 81 | 72 | 63 | 54 | 45 | 37 | 30 | 25 | 23 | 270 |
| 100 | 94 | 85 | 76 | 66 | 58 | 49 | 41 | 33 | 27 | 23 | 260 |
| 110 | 98 | 89 | 79 | 70 | 61 | 52 | 43 | 35 | 28 | 23 | 250 |
| 120 | 101 | 92 | 83 | 73 | 64 | 55 | 46 | 37 | 30 | 23 | 240 |
| 130 | 105 | 95 | 86 | 76 | 67 | 57 | 48 | 39 | 31 | 23 | 230 |
| 140 | 108 | 98 | 88 | 79 | 69 | 60 | 50 | 41 | 32 | 23 | 220 |
| 150 | 110 | 100 | 91 | 81 | 71 | 61 | 52 | 42 | 32 | 23 | 210 |
| 160 | 112 | 102 | 92 | 82 | 72 | 62 | 53 | 43 | 33 | 23 | 200 |
| 170 | 113 | 103 | 93 | 83 | 73 | 63 | 53 | 43 | 33 | 23 | 190 |
| 180 | 113 | 103 | 93 | 83 | 73 | 63 | 53 | 43 | 33 | 23 | 180 |
| North lat. | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | North lat. |

## TABLE V. — AZIMUTH OF NORTH POLE OF ECLIPTIC, FROM NORTH THROUGH WEST.

For Stations in North Latitude.

| North lat.<br>Hour angle of north pole of ecliptic. | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | North lat.<br>Hour angle of north pole of ecliptic. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0° | 0° | 0° | 0° | 0° | 0° | 0° | 0° | 180° | 180° | 180° | 0° |
| 10 | 4 | 5 | 5 | 7 | 9 | 13 | 30 | 128 | 163 | 170 | 10 |
| 20 | 8 | 9 | 11 | 13 | 16 | 24 | 45 | 106 | 147 | 160 | 20 |
| 30 | 12 | 13 | 15 | 18 | 22 | 31 | 51 | 93 | 132 | 150 | 30 |
| 40 | 16 | 17 | 19 | 22 | 27 | 36 | 53 | 84 | 119 | 140 | 40 |
| 50 | 18 | 20 | 21 | 25 | 30 | 38 | 52 | 76 | 107 | 130 | 50 |
| 60 | 21 | 22 | 24 | 26 | 31 | 38 | 50 | 70 | 96 | 120 | 60 |
| 70 | 22 | 23 | 25 | 27 | 31 | 38 | 48 | 64 | 86 | 110 | 70 |
| 80 | 23 | 24 | 25 | 27 | 31 | 36 | 45 | 58 | 77 | 100 | 80 |
| 90 | 23 | 24 | 25 | 27 | 30 | 34 | 41 | 52 | 68 | 90 | 90 |
| 100 | 23 | 23 | 24 | 25 | 28 | 31 | 37 | 46 | 60 | 80 | 100 |
| 110 | 22 | 22 | 22 | 23 | 25 | 28 | 33 | 40 | 52 | 70 | 110 |
| 120 | 21 | 20 | 20 | 21 | 23 | 25 | 29 | 35 | 44 | 60 | 120 |
| 130 | 18 | 18 | 18 | 18 | 19 | 21 | 24 | 29 | 37 | 50 | 130 |
| 140 | 16 | 15 | 15 | 15 | 16 | 17 | 19 | 23 | 29 | 40 | 140 |
| 150 | 12 | 12 | 11 | 12 | 12 | 13 | 15 | 17 | 22 | 30 | 150 |
| 160 | 8 | 8 | 8 | 8 | 8 | 9 | 10 | 12 | 14 | 20 | 160 |
| 170 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 6 | 7 | 10 | 170 |
| 180 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 180 |
| 190 | 356 | 356 | 356 | 356 | 356 | 356 | 355 | 354 | 353 | 350 | 190 |
| 200 | 352 | 352 | 352 | 352 | 352 | 351 | 350 | 348 | 346 | 340 | 200 |
| 210 | 348 | 348 | 349 | 348 | 348 | 347 | 345 | 343 | 338 | 330 | 210 |
| 220 | 344 | 345 | 345 | 345 | 344 | 343 | 341 | 337 | 331 | 320 | 220 |
| 230 | 342 | 342 | 342 | 342 | 341 | 339 | 336 | 331 | 323 | 310 | 230 |
| 240 | 339 | 340 | 340 | 339 | 337 | 335 | 331 | 325 | 316 | 300 | 240 |
| 250 | 338 | 338 | 338 | 337 | 335 | 332 | 327 | 320 | 308 | 290 | 250 |
| 260 | 337 | 337 | 336 | 335 | 332 | 329 | 323 | 314 | 300 | 280 | 260 |
| 270 | 337 | 336 | 335 | 333 | 330 | 326 | 319 | 308 | 292 | 270 | 270 |
| 280 | 337 | 336 | 335 | 333 | 329 | 324 | 315 | 302 | 283 | 260 | 280 |
| 290 | 338 | 337 | 335 | 333 | 329 | 322 | 312 | 296 | 274 | 250 | 290 |
| 300 | 339 | 338 | 336 | 334 | 329 | 322 | 310 | 290 | 264 | 240 | 300 |
| 310 | 342 | 340 | 339 | 335 | 330 | 322 | 308 | 284 | 253 | 230 | 310 |
| 320 | 344 | 343 | 341 | 338 | 333 | 324 | 307 | 276 | 241 | 220 | 320 |
| 330 | 348 | 347 | 345 | 342 | 338 | 329 | 309 | 267 | 228 | 210 | 330 |
| 340 | 352 | 351 | 349 | 347 | 344 | 336 | 315 | 254 | 213 | 200 | 340 |
| 350 | 356 | 355 | 355 | 353 | 351 | 347 | 330 | 232 | 197 | 190 | 350 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 180 | 180 | 180 | 0 |
| North lat. | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | North lat. |

## TABLE VI. — Longitude of Zenith.

For Stations in North Latitude.

| North lat. | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | North lat. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hour angle of north pole of ecliptic. | | | | | | | | | | | Hour angle of north pole of ecliptic. |
| 0° | 270° | 270° | 270° | 270° | 270° | 270° | 270° | 90° | 90° | 90° | 0° |
| 10 | 281 | 282 | 283 | 284 | 287 | 293 | 304 | 48 | 83 | 90 | 10 |
| 20 | 292 | 293 | 296 | 298 | 303 | 311 | 333 | 36 | 76 | 90 | 20 |
| 30 | 302 | 305 | 308 | 312 | 317 | 327 | 348 | 31 | 71 | 90 | 30 |
| 40 | 312 | 315 | 319 | 324 | 330 | 340 | 359 | 31 | 68 | 90 | 40 |
| 50 | 322 | 326 | 330 | 335 | 342 | 351 | 8 | 33 | 65 | 90 | 50 |
| 60 | 332 | 336 | 340 | 345 | 352 | 1 | 15 | 36 | 64 | 90 | 60 |
| 70 | 342 | 345 | 350 | 355 | 1 | 10 | 22 | 40 | 64 | 90 | 70 |
| 80 | 351 | 355 | 359 | 4 | 10 | 18 | 28 | 43 | 65 | 90 | 80 |
| 90 | 0 | 4 | 8 | 13 | 18 | 25 | 35 | 48 | 66 | 90 | 90 |
| 100 | 10 | 13 | 17 | 22 | 27 | 33 | 41 | 52 | 68 | 90 | 100 |
| 110 | 19 | 22 | 26 | 30 | 35 | 40 | 47 | 56 | 70 | 90 | 110 |
| 120 | 28 | 31 | 35 | 38 | 42 | 47 | 53 | 61 | 72 | 90 | 120 |
| 130 | 38 | 41 | 44 | 47 | 50 | 54 | 59 | 66 | 75 | 90 | 130 |
| 140 | 48 | 50 | 53 | 55 | 58 | 61 | 65 | 70 | 78 | 90 | 140 |
| 150 | 58 | 60 | 62 | 64 | 66 | 68 | 71 | 75 | 81 | 90 | 150 |
| 160 | 68 | 70 | 71 | 73 | 74 | 76 | 78 | 80 | 84 | 90 | 160 |
| 170 | 79 | 80 | 81 | 81 | 82 | 83 | 84 | 85 | 87 | 90 | 170 |
| 180 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 180 |
| 190 | 101 | 100 | 99 | 99 | 98 | 97 | 96 | 95 | 93 | 90 | 190 |
| 200 | 112 | 110 | 109 | 107 | 106 | 104 | 102 | 100 | 96 | 90 | 200 |
| 210 | 122 | 120 | 118 | 116 | 114 | 112 | 109 | 105 | 99 | 90 | 210 |
| 220 | 132 | 130 | 127 | 125 | 122 | 119 | 115 | 110 | 102 | 90 | 220 |
| 230 | 142 | 139 | 136 | 133 | 130 | 126 | 121 | 114 | 105 | 90 | 230 |
| 240 | 152 | 149 | 145 | 142 | 138 | 133 | 127 | 119 | 108 | 90 | 240 |
| 250 | 161 | 158 | 154 | 150 | 145 | 140 | 133 | 124 | 110 | 90 | 250 |
| 260 | 170 | 167 | 163 | 158 | 153 | 147 | 139 | 128 | 112 | 90 | 260 |
| 270 | 180 | 176 | 172 | 167 | 162 | 155 | 145 | 132 | 114 | 90 | 270 |
| 280 | 189 | 185 | 181 | 176 | 170 | 162 | 152 | 137 | 115 | 90 | 280 |
| 290 | 198 | 195 | 190 | 185 | 179 | 170 | 158 | 140 | 116 | 90 | 290 |
| 300 | 208 | 204 | 200 | 195 | 188 | 179 | 165 | 144 | 116 | 90 | 300 |
| 310 | 218 | 214 | 210 | 205 | 198 | 189 | 172 | 147 | 115 | 90 | 310 |
| 320 | 228 | 225 | 221 | 216 | 210 | 200 | 181 | 149 | 112 | 90 | 320 |
| 330 | 238 | 235 | 232 | 228 | 223 | 213 | 192 | 149 | 109 | 90 | 330 |
| 340 | 248 | 247 | 244 | 242 | 237 | 229 | 207 | 144 | 104 | 90 | 340 |
| 350 | 259 | 258 | 257 | 256 | 253 | 247 | 236 | 132 | 97 | 90 | 350 |
| 0 | 270 | 270 | 270 | 270 | 270 | 270 | 270 | 90 | 90 | 90 | 0 |
| North lat. | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | North lat. |

## TABLE VII. — ZENITH DISTANCE OF NORTH POLE OF ECLIPTIC.

**For Stations in South Latitude.**

| South lat. | | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | South lat. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hour angle of north pole of ecliptic. | 0° | 67° | 77° | 87° | 97° | 107° | 117° | 127° | 137° | 147° | 157° | 0° | Hour angle of north pole of ecliptic. |
| | 10 | 67 | 77 | 87 | 97 | 107 | 117 | 127 | 137 | 147 | 157 | 350 | |
| | 20 | 68 | 78 | 88 | 98 | 108 | 118 | 127 | 137 | 147 | 157 | 340 | |
| | 30 | 70 | 80 | 89 | 99 | 109 | 119 | 128 | 138 | 148 | 157 | 330 | |
| | 40 | 72 | 82 | 92 | 101 | 111 | 120 | 130 | 139 | 148 | 157 | 320 | |
| | 50 | 75 | 85 | 94 | 104 | 113 | 123 | 132 | 141 | 149 | 157 | 310 | |
| | 60 | 79 | 88 | 97 | 107 | 116 | 125 | 134 | 143 | 150 | 157 | 300 | |
| | 70 | 82 | 91 | 101 | 110 | 119 | 128 | 137 | 145 | 152 | 157 | 290 | |
| | 80 | 86 | 95 | 104 | 114 | 122 | 131 | 139 | 147 | 153 | 157 | 280 | |
| | 90 | 90 | 99 | 108 | 117 | 126 | 135 | 143 | 150 | 155 | 157 | 270 | |
| | 100 | 94 | 103 | 112 | 121 | 130 | 138 | 146 | 152 | 156 | 157 | 260 | |
| | 110 | 98 | 107 | 116 | 125 | 134 | 142 | 150 | 155 | 158 | 157 | 250 | |
| | 120 | 101 | 111 | 120 | 129 | 138 | 146 | 153 | 158 | 160 | 157 | 240 | |
| | 130 | 105 | 114 | 124 | 133 | 142 | 150 | 157 | 162 | 161 | 157 | 230 | |
| | 140 | 108 | 117 | 127 | 136 | 145 | 154 | 161 | 165 | 163 | 157 | 220 | |
| | 150 | 110 | 120 | 130 | 139 | 149 | 158 | 165 | 169 | 164 | 157 | 210 | |
| | 160 | 112 | 122 | 132 | 142 | 151 | 161 | 169 | 172 | 166 | 157 | 200 | |
| | 170 | 113 | 123 | 133 | 143 | 153 | 163 | 172 | 175 | 166 | 157 | 190 | |
| | 180 | 113 | 123 | 133 | 143 | 153 | 163 | 173 | 177 | 167 | 157 | 180 | |
| South lat. | | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | South lat. | |

## TABLE VIII. — Azimuth of North Pole of Ecliptic, from North through West.

For Stations in South Latitude.

| South lat. | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | South lat. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hour angle of north pole of ecliptic. | | | | | | | | | | | Hour angle of north pole of ecliptic. |
| 0° | 0° | 0° | 0° | 0° | 0° | 0° | 0° | 0° | 0° | 0° | 0° |
| 10 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 6 | 7 | 10 | 10 |
| 20 | 8 | 8 | 8 | 8 | 8 | 9 | 10 | 12 | 14 | 20 | 20 |
| 30 | 12 | 12 | 11 | 12 | 12 | 13 | 15 | 17 | 22 | 30 | 30 |
| 40 | 16 | 15 | 15 | 15 | 16 | 17 | 19 | 23 | 29 | 40 | 40 |
| 50 | 18 | 18 | 18 | 18 | 19 | 21 | 24 | 29 | 37 | 50 | 50 |
| 60 | 21 | 20 | 20 | 21 | 23 | 25 | 29 | 35 | 44 | 60 | 60 |
| 70 | 22 | 22 | 22 | 23 | 25 | 28 | 33 | 40 | 52 | 70 | 70 |
| 80 | 23 | 23 | 24 | 25 | 28 | 31 | 37 | 46 | 60 | 80 | 80 |
| 90 | 23 | 24 | 25 | 27 | 30 | 34 | 41 | 52 | 68 | 90 | 90 |
| 100 | 23 | 24 | 25 | 27 | 31 | 36 | 45 | 58 | 77 | 100 | 100 |
| 110 | 22 | 23 | 25 | 27 | 31 | 38 | 48 | 64 | 86 | 110 | 110 |
| 120 | 21 | 22 | 24 | 26 | 31 | 38 | 50 | 70 | 96 | 120 | 120 |
| 130 | 18 | 20 | 21 | 25 | 30 | 38 | 52 | 76 | 107 | 130 | 130 |
| 140 | 16 | 17 | 19 | 22 | 27 | 36 | 53 | 84 | 119 | 140 | 140 |
| 150 | 12 | 13 | 15 | 18 | 22 | 31 | 51 | 93 | 132 | 150 | 150 |
| 160 | 8 | 9 | 11 | 13 | 16 | 24 | 45 | 106 | 147 | 160 | 160 |
| 170 | 4 | 5 | 5 | 7 | 9 | 13 | 30 | 128 | 163 | 170 | 170 |
| 180 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 180 | 180 | 180 | 180 |
| 190 | 356 | 355 | 355 | 353 | 351 | 347 | 330 | 232 | 197 | 190 | 190 |
| 200 | 352 | 351 | 349 | 347 | 344 | 336 | 315 | 254 | 213 | 200 | 200 |
| 210 | 348 | 347 | 345 | 342 | 338 | 329 | 309 | 267 | 228 | 210 | 210 |
| 220 | 344 | 343 | 341 | 338 | 333 | 324 | 307 | 276 | 241 | 220 | 220 |
| 230 | 342 | 340 | 339 | 335 | 330 | 322 | 308 | 284 | 253 | 230 | 230 |
| 240 | 339 | 338 | 336 | 334 | 329 | 322 | 310 | 290 | 264 | 240 | 240 |
| 250 | 338 | 337 | 335 | 333 | 329 | 322 | 312 | 296 | 274 | 250 | 250 |
| 260 | 337 | 336 | 335 | 333 | 329 | 324 | 315 | 302 | 283 | 260 | 260 |
| 270 | 337 | 336 | 335 | 333 | 330 | 326 | 319 | 308 | 292 | 270 | 270 |
| 280 | 337 | 337 | 336 | 335 | 332 | 329 | 323 | 314 | 300 | 280 | 280 |
| 290 | 338 | 338 | 338 | 337 | 335 | 332 | 327 | 320 | 308 | 290 | 290 |
| 300 | 339 | 340 | 340 | 339 | 337 | 335 | 331 | 325 | 316 | 300 | 300 |
| 310 | 342 | 342 | 342 | 342 | 341 | 339 | 336 | 331 | 323 | 310 | 310 |
| 320 | 344 | 345 | 345 | 345 | 344 | 343 | 341 | 337 | 331 | 320 | 320 |
| 330 | 348 | 348 | 349 | 348 | 348 | 347 | 345 | 343 | 338 | 330 | 330 |
| 340 | 352 | 352 | 352 | 352 | 352 | 351 | 350 | 348 | 346 | 340 | 340 |
| 350 | 356 | 356 | 356 | 356 | 356 | 356 | 355 | 354 | 353 | 350 | 350 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| South lat. | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | South lat. |

## TABLE IX. — LONGITUDE OF ZENITH.

For Stations in South Latitude.

| South lat.<br>Hour angle of north pole of ecliptic. | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | South lat.<br>Hour angle of north pole of ecliptic. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0° | 270° | 270° | 270° | 270° | 270° | 270° | 270° | 270° | 270° | 270° | 0° |
| 10 | 281 | 280 | 279 | 279 | 278 | 277 | 276 | 275 | 273 | 270 | 10 |
| 20 | 292 | 290 | 289 | 287 | 286 | 284 | 282 | 280 | 276 | 270 | 20 |
| 30 | 302 | 300 | 298 | 296 | 294 | 292 | 289 | 285 | 279 | 270 | 30 |
| 40 | 312 | 310 | 307 | 305 | 302 | 299 | 295 | 290 | 282 | 270 | 40 |
| 50 | 322 | 319 | 316 | 313 | 310 | 306 | 301 | 294 | 285 | 270 | 50 |
| 60 | 332 | 329 | 325 | 322 | 318 | 313 | 307 | 299 | 288 | 270 | 60 |
| 70 | 342 | 338 | 334 | 330 | 325 | 320 | 313 | 304 | 290 | 270 | 70 |
| 80 | 351 | 347 | 343 | 338 | 333 | 327 | 319 | 308 | 292 | 270 | 80 |
| 90 | 0 | 356 | 352 | 347 | 342 | 335 | 325 | 312 | 294 | 270 | 90 |
| 100 | 10 | 5 | 1 | 356 | 350 | 342 | 332 | 317 | 295 | 270 | 100 |
| 110 | 19 | 15 | 10 | 5 | 359 | 350 | 338 | 320 | 296 | 270 | 110 |
| 120 | 28 | 24 | 20 | 15 | 8 | 359 | 345 | 324 | 296 | 270 | 120 |
| 130 | 38 | 34 | 30 | 25 | 18 | 9 | 352 | 327 | 295 | 270 | 130 |
| 140 | 48 | 45 | 41 | 36 | 30 | 20 | 1 | 329 | 292 | 270 | 140 |
| 150 | 58 | 55 | 52 | 48 | 43 | 33 | 12 | 329 | 289 | 270 | 150 |
| 160 | 68 | 67 | 64 | 62 | 57 | 49 | 27 | 324 | 284 | 270 | 160 |
| 170 | 79 | 78 | 77 | 76 | 73 | 67 | 56 | 312 | 277 | 270 | 170 |
| 180 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 270 | 270 | 270 | 180 |
| 190 | 101 | 102 | 103 | 104 | 107 | 113 | 124 | 228 | 263 | 270 | 190 |
| 200 | 112 | 113 | 116 | 118 | 123 | 131 | 153 | 216 | 256 | 270 | 200 |
| 210 | 122 | 125 | 128 | 132 | 137 | 147 | 168 | 211 | 251 | 270 | 210 |
| 220 | 132 | 135 | 139 | 144 | 150 | 160 | 179 | 211 | 248 | 270 | 220 |
| 230 | 142 | 146 | 150 | 155 | 162 | 171 | 188 | 213 | 245 | 270 | 230 |
| 240 | 152 | 156 | 160 | 165 | 172 | 181 | 195 | 216 | 244 | 270 | 240 |
| 250 | 161 | 165 | 170 | 175 | 181 | 190 | 202 | 220 | 244 | 270 | 250 |
| 260 | 170 | 175 | 179 | 184 | 190 | 198 | 208 | 223 | 245 | 270 | 260 |
| 270 | 180 | 184 | 188 | 193 | 198 | 205 | 215 | 228 | 246 | 270 | 270 |
| 280 | 189 | 193 | 197 | 202 | 207 | 213 | 221 | 232 | 248 | 270 | 280 |
| 290 | 198 | 202 | 206 | 210 | 215 | 220 | 227 | 236 | 250 | 270 | 290 |
| 300 | 208 | 211 | 215 | 218 | 222 | 227 | 233 | 241 | 252 | 270 | 300 |
| 310 | 218 | 221 | 224 | 227 | 230 | 234 | 239 | 246 | 255 | 270 | 310 |
| 320 | 228 | 230 | 233 | 235 | 238 | 241 | 245 | 250 | 258 | 270 | 320 |
| 330 | 238 | 240 | 242 | 244 | 246 | 248 | 251 | 255 | 261 | 270 | 330 |
| 340 | 248 | 250 | 251 | 253 | 254 | 256 | 258 | 260 | 264 | 270 | 340 |
| 350 | 259 | 260 | 261 | 261 | 262 | 263 | 264 | 265 | 267 | 270 | 350 |
| 0 | 270 | 270 | 270 | 270 | 270 | 270 | 270 | 270 | 270 | 270 | 0 |
| South lat. | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | South lat. |

## TABLE X. — Evening Observations: Jones.

| No. of Chart. | Date. 1853. | Long. of Sun. | Lat. of Obs. | *t* | Elongation of Vertex. | | Lat. of Boundaries, Stronger Light. | | | | | | Lat. of Boundaries, Diffuse Light. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | | Elong. 60° | | Elong. 90° | | Elong. 120° | |
| | | | | | Str. | Diff. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. |
| 1 | Apr. 2 | 12° | 10°.5 | 203° | 40° | 60° | 12° | 3° | ° | ° | ° | ° | 16° | 0° | ° | ° | ° | ° |
| | | | | 210 | 44 | | 4 | 6 | | | | | | | | | | |
| | | | | 218 | 48 | | 1 | 9 | | | | | | | | | | |
| 2 | Apr. 4 | 14 | 16.9 | 210 | 40 | | 9 | 2 | | | | | | | | | | |
| | | | | 216 | 46 | | 6 | 5 | | | | | 22 | 0 | | | | |
| 3 | Apr. 5 | 15 | 18.8 | 207 | 40 | | 11 | 2 | | | | | | | | | | |
| | | | | 213 | 49 | | 6 | 5 | | | | | | | | | | |
| | | | | 216 | 54 | | 5 | 6 | | | | | | | | | | |
| | | | | 220 | 56 | | 4 | 6 | | | | | | | | | | |
| | | | | 224 | 61 | | 0 | 11 | 3 | 2 | | | | 3 | | | | |
| 5 | Apr. 7 | 17 | 22.3 | 226 | 54 | | 6 | 7 | | | | | | | | | | |
| 6 | Apr. 8 | 18 | 22.3 | 220 | 43 | | 9 | 3 | | | | | | | | | | |
| | | | | 227 | 53 | | 5 | 9 | | | | | | | | | | |
| 7 | Apr. 9 | 19 | 22.3 | 218 | 38 | | 10 | 1 | | | | | | | | | | |
| | | | | 224 | 52 | | 1 | 5 | | | | | | | | | | |
| 8 | Apr. 26 | 36 | 22.2 | 245 | | 90 | | | | | | | 16 | 14 | | | | |
| 9 | Apr. 29 | 39 | 23.9 | 240 | | 76 | 10 | 4 | | | | | 14 | 6 | | | | |
| 10 | June 7 | 76 | 26.2 | 291 | 50 | 76 | 6 | 4 | | | | | 18 | 4 | | | | |
| 11 | June 8 | 77 | 26.2 | 294 | | 76 | | | | | | | 12 | 5 | | | | |
| 14 | June 23 | 92 | 26.2 | 309 | 48 | 94 | 19 | 0 | | | | | 20 | 9 | | | | |
| | | | | 317 | 54 | | | | | | | | | | | | | |
| 15 | June 24 | 93 | 26.2 | 310 | 50 | 94 | 26 | | | | | | 24 | 20 | 14 | 6 | | |
| | | | | 318 | 58 | | 27 | | | | | | | | | | | |
| | | | | 325 | 68 | | 31 | | 18 | | | | | | | | | |
| | | | | 333 | 78 | | 31 | | 21 | | | | | | | | | |
| 16 | June 25 | 94 | 26.2 | 312 | 54 | 98 | 25 | | | | | | 26 | 26 | 18 | 6 | | |
| | | | | 319 | 62 | | 26 | | 14 | 2 | | | | | | | | |
| 17 | June 27 | 96 | 26.2 | 314 | 48 | 124 | 25 | | | | | | 31 | | 28 | | 14 | 13 |
| | | | | 326 | 63 | | 30 | | 16 | 2 | | | | | | | | |
| | | | | 343 | | 135 | | | | | | | 46 | | 40 | | 24 | 22 |
| 18 | June 29 | 98 | 26.2 | 312 | 48 | | 23 | | | | | | | | | | | |
| | | | | 315 | 54 | 139 | 27 | | | | | | 49 | | 40 | 32 | 26 | 26 |
| | | | | 323 | 64 | | 32 | | 14 | 20 | | | | | | | | |
| | | | | 330 | 75 | | 34 | | 26 | | | | | | | | | |
| | | | | 345 | 97 | | 34 | | 31 | | 20 | 12 | | | | | | |
| | | | | 353 | 106 | | 34 | | 31 | | 25 | | | | | | | |
| 19 | June 30 | 99 | 26.2 | 317 | 86 | 142 | 20 | | 20 | 8 | | | 36 | | 34 | 30 | 30 | 20 |
| | | | | 324 | 74 | | 36 | | 27 | 15 | | | | | | | | |
| 20 | July 1 | 100 | 26.2 | 318 | 53 | 89 | 20 | | | | | | 21 | 11 | | | | |
| | | | | 325 | 60 | 102 | 24 | | | | | | 24 | | | | | |
| | | | | 332 | 70 | | 24 | | 16 | 10 | | | 24 | | 16 | 12 | | |
| | | | | 347 | | 102 | | | | | | | 28 | | 19 | 18 | | |
| 21 | July 2 | 100 | 26.2 | 334 | | 86 | | | | | | | 26 | | | | | |
| 22 | July 4 | 102 | 29.1 | 313 | 45 | 71 | 24 | 10 | | | | | 24 | 24 | | | | |
| | | | | 320 | 57 | 92 | 28 | | | | | | 30 | | 18 | 10 | | |
| | | | | 335 | | 100 | | | | | | | 34 | | 23 | 18 | | |
| 24 | July 5 | 103 | 30.8 | 321 | 56 | 88 | 25 | | | | | | 26 | | | | | |
| | | | | 329 | 56 | 94 | 25 | | | | | | 27 | | 14 | 11 | | |
| | | | | 337 | | 98 | | | | | | | 28 | | 18 | 18 | | |
| 26 | July 6 | 104 | 32.2 | 323 | 51 | 94 | 19 | | | | | | 24 | | 12 | 10 | | |
| | | | | 338 | 67 | 104 | 15 | 2 | | | | | 30 | | 24 | 21 | | |

TABLE X. — *Continued.*

| No. of Chart. | Date. 1853. | Long. of Sun. | Lat. of Obs. | t. | Elongation of Vertex. | | Lat. of Boundaries, Stronger Light. | | | | | | Lat. of Boundaries, Diffuse Light. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | | Elong. 60° | | Elong. 90° | | Elong. 120° | |
| | | | | | Str. | Diff. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 28 | July 7 | 105 | 33.8 | 324 | 56 | 86 | 19 | | | | | | 27 | 17 | | | | |
| | | | | 331 | | 92 | | | | | | | 29 | | 13 | 4 | | |
| 29 | July 8 | 106 | 35.2 | 332 | 49 | 89 | 16 | | | | | | 22 | | | | | |
| | | | | 340 | | 95 | | | | | | | 25 | | 14 | 10 | | |
| 31 | July 9 | 107 | 35.2 | 337 | 64 | 90 | | | 15 | 0 | | | 24 | | | | | |
| | | | | 341 | 64 | 98 | | | 13 | 0 | | | 28 | | 18 | 14 | | |
| 41 | Aug. 4 | 132 | 21.8 | 343 | 57 | 80 | 18 | | | | | | 18 | 22 | | | | |
| | | | | 358 | | 91 | | | | | | | 22 | | 8 | 6 | | |
| 45 | Aug. 26 | 153 | 23.0 | 12 | | 79 | | | | | | | 38 | | | | | |
| 46 | Aug. 29 | 156 | 23.0 | 0 | 56 | 76 | 16 | | | | | | 24 | 16 | | | | |
| 47 | Aug. 31 | 158 | 23.0 | 2 | 51 | 74 | 16 | | | | | | 20 | 15 | | | | |
| 48 | Sept. 1 | 158 | 23.0 | 1 | 53 | 67 | 13 | | | | | | 19 | 12 | | | | |
| | | | | 7 | | 74 | | | | | | | 22 | 13 | | | | |
| | | | | 11 | 63 | | | | 4 | 3 | | | | | | | | |
| 51 | Sept. 3 | 160 | 23.0 | 6 | 60 | 70 | 22 | | | | | | 20 | 13 | | | | |
| 58 | Sept. 27 | 184 | 23.0 | 21 | 49 | 56 | 18 | | | | | | | | | | | |
| | | | | 28 | | 60 | | | | | | | | | | | | |
| | | | | 36 | | | | | | | | | 12 | | | | | |
| 59 | Sept. 28 | 185 | 23.0 | 22 | 49 | 55 | 18 | | | | | | | | | | | |
| | | | | 30 | | 61 | | | | | | | 8 | 2 | | | | |
| | | | | 37 | | 65 | | | | | | | 16 | | | | | |
| 61 | Sept. 30 | 187 | 22.4 | 24 | 46 | 54 | 18 | | | | | | | | | | | |
| | | | | 31 | | 58 | | | | | | | | | | | | |
| | | | | 39 | | 60 | | | | | | | | | | | | |
| 63 | Oct. 1 | 188 | 22.4 | 25 | 45 | 50 | 19 | | | | | | | | | | | |
| | | | | 32 | | 52 | | | | | | | | | | | | |
| | | | | 40 | | 57 | | | | | | | | | | | | |
| | | | | 51 | | 72 | | | | | | | 20 | 10 | | | | |
| 65 | Oct. 3 | 190 | 22.4 | 28 | 39 | 50 | 16 | | | | | | | | | | | |
| | | | | 34 | | 54 | | | | | | | | | | | | |
| | | | | 42 | | 59 | | | | | | | | | | | | |
| | | | | 50 | | | | | | | | | 26 | | | | | |
| 68 | Oct. 18 | 205 | 22.2 | 37 | | | | | | | | | 24 | | | | | |
| 69 | Oct. 19 | 206 | 22.2 | 43 | | 96 | | | | | | | 25 | | 12 | 16 | | |
| 70 | Oct. 20 | 207 | 22.2 | 36 | 36 | 96 | 20 | 5 | | | | | 28 | | 11 | 15 | | |
| | | | | 44 | | 104 | | | | | | | 34 | | 23 | 21 | | |
| 71 | Oct. 21 | 208 | 22.2 | 37 | 35 | | 20 | 4 | | | | | | | | | | |
| | | | | 41 | | 95 | 25 | | | | | | 22 | 22 | 8 | 11 | | |
| | | | | 45 | | 105 | | | | | | | 31 | | 16 | | | |
| | | | | 52 | | 105 | | | | | | | | | | | | |
| 72 | Oct. 22 | 209 | 22.4 | 38 | 36 | 93 | 18 | 4 | | | | | 24 | | 5 | 9 | | |
| | | | | 42 | 40 | 95 | 20 | | | | | | 29 | | 8 | 10 | | |
| | | | | 46 | | 102 | 28 | | | | | | 34 | | 19 | | | |
| | | | | 68 | | 105 | | | | | | | 42 | | 23 | | | |
| 73 | Oct. 27 | 214 | 22.4 | 51 | | 96 | | | | | | | 32 | | 16 | 15 | | |
| | | | | 66 | | 99 | | | | | | | 37 | | 20 | 17 | | |
| 74 | Oct. 28 | 215 | 22.4 | 45 | | 87 | | | | | | | 25 | | | | | |
| | | | | 52 | | 92 | | | | | | | 32 | | 9 | 5 | | |
| 76 | Oct. 29 | 216 | 22.4 | 43 | 32 | | 8 | 2 | | | | | | | | | | |
| | | | | 45 | 42 | 87 | 14 | | | | | | 23 | | | | | |
| | | | | 53 | 71 | 94 | 25 | | 11 | 10 | | | 31 | | 10 | 14 | | |
| | | | | 79 | 81 | 103 | | | | | | | 38 | | 19 | 22 | | |

## TABLE X. — *Continued.*

| No. of Chart. | Date. 1853–54. | Long. of Sun. | Lat. of Obs. | t. | Elongation of Vertex. | | Lat. of Boundaries, Stronger Light. | | | | | | Lat. of Boundaries. Diffuse Light. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | | Elong. 60° | | Elong. 90° | | Elong. 120° | |
| | | | | | Str. | Diff. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 78 | Oct. 31 | 218 | 22.4 | 47 | 30 | | | | | | | | | | | | | |
| | | | | 51 | | 92 | | | | | | | 23 | 20 | 6 | 10 | | |
| | | | | 55 | 71 | 100 | | | 10 | 9 | | | 28 | | 16 | 21 | | |
| | | | | 70 | 77 | 106 | | | 18 | 9 | | | 40 | | 24 | 25 | | |
| | | | | 85 | 95 | 109 | | | | | 11 | 6 | | | 36 | 28 | | |
| | | | | 107 | 92 | | | | | | 4 | 3 | | | | | | |
| 83 | Nov. 4 | 222 | 22.4 | 79 | 79 | 106 | | | 17 | 10 | | | | | 30 | 22 | | |
| | | | | 89 | 82 | 110 | | | 20 | 10 | | | | | 34 | 24 | | |
| | | | | 104 | 94 | 114 | | | 17 | 10 | 8 | 8 | | | 36 | 24 | | |
| | | | | 119 | | 120 | | | | | | | | | | 25 | | |
| 84 | Nov. 5 | 223 | 22.4 | 90 | 79 | 108 | | | 18 | | | | | | 30 | 23 | | |
| | | | | 105 | 97 | 118 | | | | | 6 | 8 | | | 35 | 24 | | |
| | | | | 120 | 102 | | | | | | 10 | 8 | | | | | | |
| 86 | Nov. 22 | 240 | 22.3 | 77 | 56 | 98 | | | | | | | 24 | 26 | 12 | 15 | | |
| 88 | Dec. 21 | 269 | 23.1 | 98 | 76 | | | | 9 | 9 | | | | | | | | |
| | | | | 105 | 82 | 120 | | | 11 | 16 | | | 20 | 29 | 18 | 18 | | |
| 89 | Dec. 28 | 276 | 22.3 | 112 | 72 | 122 | | | 8 | 8 | | | 26 | 24 | 21 | | | |
| | | | | 119 | 85 | 132 | | | 10 | 8 | | | 26 | 24 | 23 | 18 | | |
| | | | | 127 | 98 | 137 | | | 10 | 10 | 8 | 6 | | 24 | 25 | 19 | | |
| | | | | 142 | 110 | 148 | | | 10 | | 10 | 8 | | 24 | 26 | 20 | | |
| 91 | Dec. 29 | 277 | 22.3 | 109 | | 99 | | | | | | | 16 | 16 | 10 | 10 | | |
| | | | | 113 | 64 | | | | 5 | 5 | | | | | | | | |
| | | | | 117 | 68 | 107 | | | 6 | 6 | | | 23 | 21 | 15 | 16 | | |
| | | | | 120 | 76 | 113 | | | 9 | 7 | | | 23 | 21 | 16 | 16 | | |
| | | | | 135 | 82 | 134 | | | 10 | 7 | | | 23 | 21 | 17 | 17 | 10 | 12 |
| | | | | 150 | | 147 | | | | | | | 30 | 22 | 26 | 19 | 20 | 16 |
| 93 | Dec. 30 | 278 | 22.3 | 110 | 63 | 105 | 16 | 10 | 6 | 7 | | | 10 | 15 | 7 | 6 | | |
| | | | | 118 | 70 | | 16 | 10 | 9 | 9 | | | | | | | | |
| | | | | 119 | | 127 | | | | | | | 18 | 17 | 13 | 11 | 8 | 6 |
| | | | | 125 | 79 | 134 | | | 11 | 9 | | | 24 | 21 | 20 | 17 | 13 | 14 |
| | | | | 129 | 90 | | | | 12 | 11 | | | | | | | | |
| | | | | 137 | 94 | 144 | | | 12 | 11 | 6 | 7 | 24 | 20 | 21 | 18 | 16 | 16 |
| | | | | 152 | | 147 | | | | | | | 24 | 20 | 22 | 19 | 18 | 18 |
| 96 | Jan. 2 | 282 | 22.3 | 139 | 87 | 132 | | | 8 | 8 | | | | | 15 | 16 | 8 | 11 |
| | | | | 154 | 91 | 144 | | | 8 | 8 | 1 | 1 | | | 21 | 16 | 14 | 14 |
| | | | | 169 | | 144 | | | | | | | | | 21 | 16 | 13 | 14 |
| | | | | 192 | | 142 | | | | | | | | | 18 | 16 | 11 | 13 |
| | Jan. 3 | | | 207 | | 142 | | | | | | | | | 18 | 16 | 11 | 13 |
| 98 | Jan. 3 | 283 | 22.3 | 158 | 100 | 138 | | | | | 6 | 5 | | | 14 | 15 | 10 | 13 |
| | | | | 163 | 112 | | | | | | 6 | 5 | | | | | | |
| | | | | 178 | | 145 | | | | | | | | | 19 | 20 | 13 | 17 |
| | | | | 193 | | 145 | | | | | | | | | | | 16 | 17 |
| | Jan. 4 | | | 208 | | 145 | | | | | | | | | | | 16 | 17 |
| 104 | Jan. 18 | 298 | 23.7 | 125 | 66 | 119 | 9 | 7 | 4 | 4 | | | 17 | 16 | 11 | 14 | | |
| | | | | 140 | 76 | 126 | | | 6 | 6 | | | 21 | 19 | 15 | 17 | 8 | 9 |
| 105 | Jan. 24 | 304 | 26.2 | 149 | | 124 | | | | | | | 17 | 16 | 12 | 14 | 6 | 7 |
| 106 | Jan. 25 | 305 | 26.2 | 140 | 67 | 122 | 10 | 7 | 5 | 5 | | | 12 | 12 | 8 | 8 | 2 | 4 |
| | | | | 151 | 80 | 136 | | | 8 | 8 | | | 24 | 14 | 18 | 11 | 10 | 7 |
| 107 | Jan. 26 | 306 | 26.2 | 156 | 79 | 132 | | | 9 | 7 | | | 24 | 16 | 19 | 14 | 10 | 6 |
| | | | | 171 | 83 | 132 | | | 12 | 9 | | | 27 | 19 | 21 | 16 | 12 | 8 |
| | | | | 178 | 90 | | | | 12 | 9 | | | | | | | | |

TABLE X. — *Continued.*

| No. of Chart. | Date. 1854. | Long. of Sun. | Lat. of Obs. | t. | Elongation of Vertex. | | Lat. of Boundaries, Stronger Light. | | | | | | Lat. of Boundaries, Diffuse Light. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | | Elong. 60° | | Elong. 90° | | Elong. 120° | |
| | | | | | Str. | Diff. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. |
| 109 | Jan. 27 | 307° | 26°.2 | 142° | 78° | 121° | ° | ° | 9° | 7° | ° | ° | 25° | 17° | 18° | 12° | 3° | 4° |
| | | | | 157 | 84 | 125 | | | 12 | 10 | | | 25 | 18 | 20 | 14 | 9 | 8 |
| 111 | Jan. 30 | 310 | 26.2 | 157 | 71 | 118 | | | 10 | 9 | | | 28 | 19 | 19 | 15 | | |
| | | | | 158 | 63 | | | | 2 | 2 | | | | | | | | |
| 113 | Jan. 31 | 311 | 26.5 | 161 | 60 | 114 | | | | | | | 24 | 14 | 14 | 10 | | |
| | | | | 166 | 71 | | | | 7 | 6 | | | | | | | | |
| | | | | 176 | 79 | 118 | | | 12 | 8 | | | 26 | 18 | 17 | 13 | | |
| 117 | Feb. 15 | 326 | 35.3 | 160 | 70 | | | | 4 | 7 | | | 16 | 17 | 13 | 10 | | |
| | | | | 162 | 81 | | | | 6 | 9 | | | | | | | | |
| 118 | Feb. 17 | 328 | 35.3 | 162 | 65 | | 13 | 7 | 6 | 6 | | | 22 | 15 | 14 | 12 | | |
| | | | | 170 | 80 | | 14 | 8 | 9 | 7 | | | 24 | 18 | 17 | 16 | | |
| | | | | 177 | 85 | | | | 11 | 7 | | | 24 | 18 | 17 | 16 | | |
| | | | | 192 | 91 | | | | 12 | 8 | 4 | 3 | 24 | 18 | 17 | 16 | | |
| 119 | Feb. 18 | 329 | 35.3 | 163 | 71 | | | | 7 | 8 | | | 19 | 13 | 12 | 10 | | |
| | | | | 178 | 91 | | | | 10 | 7 | 2 | 4 | 23 | 17 | 16 | 14 | | |
| | | | | 193 | 95 | | | | 11 | 7 | 4 | 6 | 23 | 17 | 16 | 14 | | |
| 120 | Feb. 20 | 331 | 35.3 | 165 | 56 | | 10 | 8 | | | | | 22 | 15 | 16 | 10 | | |
| | | | | 167 | 67 | | 12 | 8 | 6 | 6 | | | | | | | | |
| | | | | 169 | 75 | | 14 | 8 | 9 | 6 | | | | | | | | |
| 121 | Feb. 21 | 332 | 35.3 | 174 | 77 | | | | 8 | 6 | | | 22 | 17 | 14 | 14 | | |
| | | | | 181 | 90 | | | | 9 | 6 | | | | | | | | |
| 122 | Feb. 23 | 334 | 35.3 | 175 | 51 | | 8 | 4 | | | | | 21 | 14 | 14 | 8 | | |
| | | | | 177 | 78 | | | | 7 | 7 | | | | | | | | |
| | | | | 180 | 84 | | | | 9 | 9 | | | | | | | | |
| | | | | 190 | 93 | | | | 9 | 9 | 3 | 3 | 24 | 16 | | | | |
| 123 | Feb. 24 | 335 | 35.4 | 180 | 84 | | | | 7 | 6 | | | 21 | 19 | | 16 | | |
| | | | | 199 | 90 | | | | 9 | 9 | | | 26 | 22 | | 20 | | |
| 124 | Feb. 25 | 336 | 35.4 | 174 | 85 | | 13 | 8 | 8 | 7 | | | 23 | 14 | | 11 | | |
| | | | | 200 | 95 | | | | 10 | 7 | 4 | 4 | 27 | 18 | | 15 | | |
| 127 | Mar. 18 | 357 | 35.4 | 201 | 72 | | 10 | 8 | 5 | 6 | | | 22 | 12 | | | | |
| | | | | 221 | 79 | | | | 10 | 9 | | | 22 | 12 | | | | |
| 128 | Mar. 20 | 359 | 35.4 | 200 | 73 | | | | 7 | 4 | | | | 10 | | | | |
| | | | | 223 | | | | | 9 | 7 | | | | | | | | |
| 129 | Mar. 25 | 4 | 35.4 | 209 | | 108 | | | 7 | 4 | | | | 13 | 12 | 8 | | |
| | | | | 235 | 104 | | | | 9 | 7 | 6 | 4 | | | | | | |
| 131 | Mar. 27 | 6 | 35.4 | 207 | 60 | | 9 | 6 | | | | | | 12 | | | | |
| | | | | 237 | 101 | | | | 9 | 6 | 7 | 4 | | | | | | |
| 133 | Mar. 28 | 7 | 35.4 | 246 | 105 | 116 | | | 10 | 6 | 8 | 4 | | | 18 | | | |
| 135 | Mar. 29 | 8 | 35.4 | 212 | 62 | 110 | 10 | 6 | 4 | 0 | | | | 12 | 16 | 9 | | |
| | | | | 232 | | 118 | | | | | | | | 16 | 20 | 12 | | |
| | | | | 247 | 104 | | | | 12 | 6 | 10 | 3 | | | | | | |
| 136 | Mar. 30 | 9 | 35.4 | 214 | 62 | 114 | 10 | 6 | 6 | *1* | | | 24 | 16 | 20 | 9 | | |
| | | | | 233 | | 114 | | | | | | | 24 | 16 | 20 | 9 | | |
| | | | | 238 | 101 | | | | 13 | 6 | 10 | 0 | | | | | | |
| | | | | 248 | 104 | | | | 15 | 7 | 12 | 2 | | | | | | |
| 138 | Apr. 17 | 27 | 35.3 | 230 | 86 | 111 | | | 11 | 4 | | | 22 | | 18 | 6 | | |
| | | | | 247 | 96 | 118 | | | 11 | 6 | 9 | 1 | 22 | | 20 | 12 | | |
| | | | | 274 | 96 | 118 | | | 11 | 6 | 9 | 1 | 22 | | 20 | 12 | | |
| 139 | Apr. 18 | 28 | 34.7 | 237 | 84 | 116 | | | 11 | 4 | | | 22 | | 20 | 9 | | |
| | | | | 252 | 97 | 121 | | | 15 | 8 | 11 | *2* | 24 | | 22 | 14 | | |

## TABLE X.— *Continued.*

| No. of Chart. | Date. 1854. | Long. of Sun. | Lat. of Obs. | *t.* | Elongation of Vertex. | | Lat. of Boundaries, Stronger Light. | | | | | | Lat. of Boundaries, Diffuse Light. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | | Elong. 60° | | Elong. 90° | | Elong. 120° | |
| | | | | | Str. | Diff. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 140 | Apr. 20 | 30 | 34.7 | 237 | 82 | | 16 | 9 | 11 | 5 | | | | | | | | |
| | | | | 239 | | 98 | | | | | | | 22 | | 14 | 3 | | |
| | | | | 254 | 93 | 116 | | | 12 | 7 | 6 | 1 | 25 | | 21 | 13 | | |
| | | | | 269 | 93 | 116 | | | 12 | 7 | 6 | 1 | 25 | | 21 | 13 | | |
| 141 | Apr. 21 | 31 | 34.7 | 238 | 79 | | | | 10 | 4 | | | | | | | | |
| | | | | 240 | | 102 | | | | | | | 20 | | 14 | 9 | | |
| | | | | 255 | 93 | 115 | | | 8 | 5 | 4 | 2 | 26 | | 21 | 14 | | |
| | | | | 270 | 93 | 115 | | | 8 | 5 | 4 | 2 | 26 | | 21 | 14 | | |
| 143 | Apr. 24 | 34 | 34.7 | 243 | 90 | 107 | | | 11 | 4 | | | 16 | | 20 | 10 | | |
| | | | | 258 | 96 | 112 | | | 12 | 6 | 7 | 2 | 19 | | 24 | 12 | | |
| | | | | 273 | 96 | 112 | | | 12 | 6 | 7 | 2 | 19 | | 24 | 12 | | |
| 144 | Apr. 25 | 35 | 34.7 | 244 | 90 | 108 | 15 | 6 | 10 | 5 | | | 16 | | 19 | 12 | | |
| | | | | 259 | 95 | 116 | | | 12 | 5 | 6 | 2 | 20 | | 25 | 14 | | |
| 146 | Apr. 26 | 36 | 34.7 | 245 | 89 | 111 | | | 10 | 4 | | | 16 | 14 | 20 | 10 | | |
| | | | | 260 | 96 | 118 | | | 12 | 6 | 6 | 3 | 21 | 16 | 26 | 13 | | |
| 148 | Apr. 28 | 38 | 34.7 | 254 | 92 | 110 | | | 10 | 4 | 4 | 0 | 26 | | 21 | 13 | | |
| | | | | 269 | 100 | 116 | | | 11 | 7 | 6 | 4 | 28 | | 24 | 16 | | |
| 149 | Apr. 29 | 39 | 34.7 | 248 | 88 | 107 | | | 10 | 4 | | | 26 | | 20 | 12 | | |
| 152 | May 15 | 54 | 40.2 | 273 | 71 | 106 | | | 16 | 3 | 7 | 3 | 28 | 13 | 22 | 8 | | |
| | | | | 281 | 76 | 116 | | | 18 | | 9 | 3 | 31 | 15 | 26 | 12 | | |
| 153 | May 16 | 55 | 41.8 | 275 | 71 | 108 | 16 | | 7 | 2 | | | 27 | 15 | 24 | 12 | | |
| | | | | 285 | 76 | 120 | 18 | | 10 | 2 | | | 32 | 20 | 29 | 18 | | |
| | | | | 294 | 90 | 120 | 21 | | 13 | 2 | | | 32 | 20 | 29 | 18 | | |
| 154 | May 17 | 56 | 41.8 | 280 | 74 | 104 | 15 | | 8 | 2 | | | 30 | 15 | 24 | 12 | | |
| | | | | 288 | 91 | 114 | 19 | | 12 | 2 | 3 | 0 | 32 | 16 | 28 | 14 | | |
| | | | | 295 | 99 | 120 | 21 | | 14 | 2 | 7 | 2 | 32 | 16 | 30 | 16 | | |
| 155 | May 19 | 58 | 41.8 | 282 | 74 | 111 | 18 | | 7 | 3 | | | 30 | 16 | 25 | 13 | | |
| | | | | 297 | 97 | 118 | 20 | | 12 | 3 | 4 | 3 | 31 | | 29 | 16 | | |
| 156 | May 20 | 59 | 41.8 | 287 | 98 | | 67 | | 11 | 4 | 6 | 4 | | | | | | |
| | | | | 288 | | 114 | | | | | | | 30 | 20 | 27 | 16 | | |
| | | | | 298 | 102 | 119 | 70 | | 14 | 2 | 8 | 3 | 34 | 20 | 30 | 18 | | |
| 158 | May 22 | 61 | 41.8 | 285 | 92 | 110 | 20 | | 13 | 5 | 4 | 2 | 36 | 19 | 30 | 13 | | |
| | | | | 303 | 99 | 124 | 20 | | 14 | 5 | 7 | 4 | 37 | 19 | 33 | 16 | 16 | 4 |
| 161 | May 29 | 68 | 41.8 | 294 | 100 | 124 | 23 | | 15 | 4 | 7 | 4 | 36 | 20 | 30 | 17 | 17 | 8 |
| | | | | 314 | 106 | 142 | 27 | | 19 | 4 | 11 | 4 | 38 | 20 | 35 | 18 | 31 | 16 |
| 166 | June 21 | 90 | 34.7 | 313 | 87 | 120 | | | 12 | 3 | | | 30 | | 23 | 16 | | |
| | | | | 315 | 97 | 122 | | | 15 | 3 | 7 | 3 | 32 | | 27 | 16 | 10 | 4 |
| | | | | 330 | 105 | 125 | | | 18 | 3 | 10 | 3 | 36 | | 32 | 16 | 18 | 8 |
| 167 | June 22 | 91 | 34.7 | 316 | 103 | 119 | | | 18 | 4 | 9 | 3 | 32 | 18 | 25 | 15 | | |
| | | | | 331 | 112 | 132 | | | 23 | 3 | 12 | 2 | 42 | | 39 | 18 | 25 | 12 |
| 168 | June 24 | 93 | 34.7 | 318 | 104 | 134 | | | 15 | 3 | 8 | 2 | 34 | | 29 | 18 | 23 | 13 |
| | | | | 333 | 114 | 138 | | | 18 | 3 | 11 | 2 | 40 | | 34 | 18 | 27 | 16 |
| 169 | June 27 | 96 | 33.0 | 321 | 98 | 127 | 26 | | 16 | 4 | 5 | 3 | 36 | | 29 | 18 | 15 | 10 |
| | | | | 336 | 106 | 131 | 28 | | 18 | 4 | 8 | 3 | 40 | | 32 | 18 | 20 | 14 |
| 171 | June 29 | 98 | 28.5 | 338 | 106 | 128 | | | 16 | 4 | 10 | 3 | 36 | | 33 | 15 | 22 | 10 |
| 179 | July 13 | 111 | 25.2 | 337 | 116 | 130 | | | 16 | 4 | 12 | 0 | 35 | | 30 | 17 | 23 | 9 |
| 180 | July 14 | 112 | 25.2 | 327 | 85 | 120 | | | 13 | 1 | | | 31 | | 26 | 15 | | |
| | | | | 338 | 102 | 130 | | | 14 | 1 | 8 | 0 | 35 | | 28 | 18 | 20 | 9 |
| | | | | 349 | 114 | 133 | | | 17 | 1 | 11 | 0 | 38 | | 81 | 18 | 23 | 12 |
| 181 | July 15 | 113 | 25.2 | 324 | 76 | 119 | 16 | 2 | 10 | 0 | | | 29 | | 22 | 14 | | |
| | | | | 339 | 98 | 126 | | | 14 | 1 | 9 | 1 | 34 | | 28 | 14 | 18 | 6 |
| | | | | 354 | 113 | 128 | | | 17 | 3 | 12 | 1 | 38 | | 31 | 15 | 22 | 9 |

TABLE X. — *Continued.*

| No. of Chart. | Date. 1854. | Long. of Sun. | Lat. of Obs. | *t.* | Elongation of Vertex. | | Lat. of Boundaries, Stronger Light. | | | | | | Lat. of Boundaries, Diffuse Light. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | | Elong. 60° | | Elong. 90° | | Elong 120° | |
| | | | | | Str. | Diff. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 182 | July 18 | 115 | 25.2 | 341 | 100 | 123 | | | 12 | 3 | 8 | 0 | 31 | | 24 | 14 | 10 | 2 |
| | | | | 351 | 113 | 127 | | | 16 | 3 | 12 | 0 | 35 | | 28 | 14 | 18 | 6 |
| 183 | July 19 | 116 | 25.2 | 335 | 94 | 120 | | | 12 | 2 | 6 | 0 | 33 | | 28 | 14 | | |
| | | | | 350 | 111 | 121 | | | 18 | 3 | 12 | 2 | 37 | | 30 | 14 | 14 | 0 |
| 184 | July 20 | 117 | 25.2 | 332 | 99 | 122 | | | 12 | 2 | 8 | 0 | 32 | | 25 | 14 | 12 | 2 |
| | | | | 343 | 107 | 124 | | | 13 | 4 | 9 | 2 | 35 | | 28 | 14 | 16 | 4 |
| | | | | 350 | 112 | 124 | | | 15 | 4 | 12 | 2 | 38 | | 31 | 14 | 20 | 4 |
| 185 | July 21 | 118 | 25.2 | 336 | 91 | 120 | | | 12 | 3 | 3 | 0 | 31 | | 24 | 14 | | |
| 186 | July 22 | 119 | 25.2 | 334 | 91 | 118 | | | 12 | 2 | 3 | 0 | 33 | | 24 | 13 | | |
| | | | | 349 | 97 | 122 | | | 16 | 2 | 11 | 2 | 40 | | 29 | 13 | 14 | 2 |
| | | | | 356 | 110 | 122 | | | | | 12 | 2 | 40 | | 29 | 13 | 14 | 2 |
| 188 | July 24 | 121 | 25.6 | 332 | 68 | | 17 | 3 | 9 | 2 | | | | | | | | |
| | | | | 336 | 92 | 119 | | | 13 | 3 | 6 | *2* | 33 | | 26 | 16 | | |
| | | | | 343 | 104 | 123 | | | 15 | 3 | 11 | 2 | 38 | | 31 | 16 | 14 | 4 |
| | | | | 358 | | 123 | | | | | | | 38 | | 31 | 16 | 14 | 4 |
| 190 | July 25 | 122 | 25.0 | 337 | 88 | 114 | | | 11 | 3 | | | 33 | 15 | 26 | 14 | | |
| | | | | 348 | 106 | 118 | | | 15 | 3 | 10 | 2 | 38 | 15 | 30 | 14 | | |
| 196 | Aug. 12 | 140 | 14.6 | 343 | 90 | 106 | | | 15 | 2 | | | 32 | | 21 | 13 | | |
| | | | | 358 | 92 | 108 | | | 17 | 2 | 8 | *2* | 35 | | 24 | 13 | | |
| 197 | Aug. 17 | 144 | 14.3 | 348 | 87 | | 17 | | 11 | 2 | | | 34 | 20 | 25 | 14 | | |
| | | | | 3 | 92 | | | | 14 | 4 | 6 | *1* | 34 | 20 | 25 | 14 | | |
| | | | | 18 | 96 | | | | 14 | 4 | 7 | 2 | 34 | 20 | 27 | 14 | | |
| 198 | Aug. 18 | 145 | 14.4 | 349 | 86 | 101 | 17 | | 11 | 3 | | | 32 | | 21 | 10 | | |
| | | | | 357 | 92 | | | | 14 | 5 | 6 | *1* | | | | | | |
| | | | | 12 | 95 | | | | 14 | | 7 | 2 | | | | | | |
| 200 | Aug. 21 | 148 | 14.7 | 352 | 84 | 99 | | | 12 | 3 | | | 29 | 20 | 20 | 12 | | |
| | | | | 8 | 88 | | | | 12 | 3 | | | 31 | 20 | 24 | | | |
| 202 | Aug. 22 | 149 | 15.8 | 353 | 89 | 100 | 16 | | 11 | 4 | | | 33 | 20 | 23 | 13 | | |
| | | | | 8 | 93 | | | | 14 | 4 | 7 | 0 | 38 | | 28 | | | |
| 204 | Aug. 23 | 150 | 18.0 | 355 | 86 | | | | 11 | 3 | | | | | | | | |
| | | | | 0 | 88 | | | | 12 | 3 | | | 34 | 20 | 25 | 14 | | |
| 206 | Aug. 25 | 152 | 20.8 | 0 | 84 | | | | 10 | 4 | | | | | | | | |
| | | | | 4 | 86 | | | | 12 | 4 | | | | | | | | |
| | | | | 11 | 90 | 100 | | | | | | | 31 | 19 | 19 | | | |
| 212 | Sept. 12 | 169 | 22.2 | 11 | 74 | | 20 | 4 | 8 | 2 | | | 34 | | | | | |
| | | | | 18 | 77 | | 24 | 4 | 11 | 2 | | | 38 | | | | | |
| 213 | Sept. 13 | 170 | 23.1 | 12 | 69 | | 24 | 6 | 7 | 1 | | | 32 | 10 | | | | |
| | | | | 20 | 74 | | | | 9 | 1 | | | | | | | | |
| 214 | Sept. 14 | 171 | 24.1 | 13 | 73 | | 25 | | 8 | 1 | | | 31 | 11 | | | | |
| | | | | 21 | 77 | | 30 | | 10 | 1 | | | 31 | 11 | | | | |
| 215 | Sept. 16 | 173 | 27 5 | 15 | 72 | | 26 | | 7 | 1 | | | 30 | | | | | |
| | | | | 20 | 75 | | 30 | | 10 | 3 | | | 30 | | | | | |
| 218 | Sept. 20 | 177 | 33.5 | 18 | | | 21 | | 7 | 1 | | | | | | | | |
| | | | | 19 | | | | | | | | | 37 | | | | | |
| | | | | 25 | | 111 | 21 | | 7 | 2 | | | 41 | | 22 | 19 | | |
| | | | | 36 | | 114 | | | | | | | 42 | | 26 | 19 | | |
| 220 | Sept. 23 | 180 | 34.7 | 25 | | 110 | 12 | | 6 | 3 | | | 32 | | 16 | 17 | | |
| | | | | 40 | | 111 | | | | | | | 36 | | 21 | 17 | | |
| 224 | Oct. 11 | 198 | 35.4 | 34 | | | 23 | | | | | | | | | | | |
| | | | | 38 | | | | | 6 | 4 | | | | | | | | |
| | | | | 40 | | 104 | | | | | | | 34 | | 21 | 16 | | |
| | | | | 44 | | | | | 8 | | | | | | | | | |

### TABLE X. — *Continued.*

| No. of Chart. | Date. 1854. | Long. of Sun. | Lat. of Obs. | *t*. | Elongation of Vertex. | | Lat. of Boundaries, Stronger Light. | | | | | | Lat. of Boundaries, Diffuse Light. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | | Elong. 60° | | Elong. 90° | | Elong. 120° | |
| | | | | | Str. | Diff. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. |
| 225 | Oct. 12 | 199° | 35.5° | 41° | ° | 100° | ° | ° | ° | ° | ° | ° | 31° | ° | 17° | 13° | ° | ° |
| | | | | 43 | | | 15 | | | | | | | | | | | |
| | | | | 46 | | 103 | | | | | | | 34 | | 22 | 15 | | |
| 226 | Oct. 14 | 201 | 33.8 | 45 | | 101 | 25 | | 6 | | | | 30 | | 16 | 16 | | |
| | | | | 53 | | 104 | | | | | | | 36 | | 22 | 17 | | |
| 227 | Oct. 16 | 203 | 33.3 | 38 | | | 23 | | | | | | | | | | | |
| | | | | 40 | | 90 | 25 | | | | | | 28 | | | | | |
| | | | | 50 | | 98 | 27 | | | | | | 32 | | 14 | 16 | | |
| 229 | Oct. 16 | 203 | 33.0 | 40 | | 91 | 24 | | 4 | | | | 28 | | 6 | 2 | | |
| | | | | 48 | | 99 | 28 | | 8 | | | | 34 | | 18 | 14 | | |
| 230 | Oct. 17 | 204 | 31.9 | 40 | | | 23 | | | | | | | | | | | |
| | | | | 43 | | 98 | | | 6 | | | | 28 | | 14 | 14 | | |
| 231 | Oct. 18 | 205 | 30.7 | 40 | | | 23 | | 2 | | | | | | | | | |
| | | | | 41 | | 92 | | | | | | | 30 | | 9 | 7 | | |
| 234 | Oct. 21 | 208 | 24.8 | 43 | | 93 | 20 | 4 | 8 | | | | 28 | | 9 | 8 | | |
| 235 | Oct. 23 | 210 | 21.3 | 47 | 75 | 93 | 22 | | 3 | 4 | | | 30 | | 15 | 2 | | |
| | | | | 62 | 80 | 98 | | | | | | | 34 | | 19 | 7 | | |
| 239 | Nov. 11 | 229 | 23.9 | 66 | | 96 | | | | | | | 31 | 27 | 20 | 14 | | |
| | | | | 70 | 64 | | | | 4 | 5 | | | | | | | | |
| | | | | 75 | 69 | | | | 4 | 5 | | | | | | | | |
| 240 | Nov. 13 | 231 | 26.5 | 68 | 66 | 82 | 12 | | 4 | 5 | | | 32 | 15 | | | | |
| 242 | Nov. 20 | 238 | 36.9 | 68 | 67 | 84 | | | 5 | 4 | | | 28 | 19 | | | | |
| | | | | 83 | 76 | 93 | | | 6 | 5 | | | 30 | 18 | 10 | 8 | | |
| 244 | Nov. 22 | 240 | 37.8 | 75 | 68 | 84 | | | 6 | 4 | | | 27 | 15 | | | | |
| 249 | Dec. 7 | 255 | 38.0 | 83 | 78 | 106 | 7 | | 6 | 5 | | | 26 | 22 | 17 | 13 | | |
| | | | | 95 | 80 | | 7 | | 8 | 5 | | | | | | | | |
| 250 | Dec. 8 | 256 | 38.0 | 85 | 77 | 104 | | | 5 | 5 | | | 24 | 22 | 16 | 16 | | |
| | | | | 100 | 81 | 104 | | | 7 | 5 | | | 24 | 22 | 16 | 16 | | |
| 251 | Dec. 9 | 257 | 38.0 | 86 | 78 | 102 | 6 | | 5 | 6 | | | 24 | 21 | 18 | 15 | | |
| | | | | 101 | 82 | 104 | | | 8 | 6 | | | 28 | 21 | 20 | 15 | | |
| | | | | 108 | 86 | 104 | | | 8 | 6 | | | 28 | 21 | 20 | 15 | | |
| 252 | Dec. 11 | 259 | 38.0 | 84 | 76 | 98 | | | 6 | 4 | | | 21 | 20 | 15 | 9 | | |
| | | | | 95 | 81 | 100 | | | 7 | 5 | | | 24 | 20 | 20 | 10 | | |
| 253 | Dec. 12 | 260 | 38.0 | 85 | 73 | 94 | | | 6 | 3 | | | 22 | 19 | 14 | 4 | | |
| | | | | 100 | 78 | 98 | | | 7 | 4 | | | 24 | 20 | 19 | 8 | | |
| | | | | 113 | 83 | 98 | | | 6 | 3 | | | 24 | 20 | 19 | 8 | | |
| 254 | Dec. 13 | 261 | 37.8 | 86 | 74 | 96 | | | 7 | 3 | | | 20 | 20 | 13 | 8 | | |
| | | | | 101 | 80 | 100 | | | 6 | 4 | | | 25 | 20 | 19 | 10 | | |
| | | | | 116 | 84 | | | | 4 | 3 | | | | | | | | |
| 255 | Dec. 15 | 263 | 37.8 | 134 | 112 | 122 | | | | | 7 | 4 | | | 16 | 19 | 3 | 4 |
| 256 | Dec. 16 | 264 | 37.3 | 91 | 76 | 96 | | | 7 | 3 | | | 18 | | 12 | 8 | | |
| | | | | 107 | 81 | 98 | | | 6 | 4 | | | 26 | | 18 | 8 | | |
| | | | | 130 | | | | | | | 6 | | | | | | | |
| 258 | Dec. 18 | 266 | 31.7 | 113 | 84 | 96 | | | 7 | 6 | | | 24 | 18 | 16 | 9 | | |
| | | | | 124 | 91 | 104 | | | 8 | 6 | *1* | 5 | 28 | 20 | 23 | 14 | | |
| 260 | Dec. 19 | 267 | 29.6 | 95 | 77 | 100 | | | 5 | 3 | | | 23 | 17 | 18 | 11 | | |
| | | | | 110 | 79 | 106 | | | 6 | 3 | | | 27 | 20 | 23 | 14 | | |
| | | | | 129 | 87 | | | | 9 | 3 | | | | | | | | |
| 262 | Dec. 20 | 268 | 26.9 | 96 | 76 | 100 | 7 | | 5 | 3 | | | 22 | 18 | 17 | 9 | | |
| | | | | 111 | 82 | 105 | | | 7 | 3 | | | 26 | 22 | 21 | 13 | | |
| | | | | 179 | | 152 | | | | | | | | | | | 9 | 9 |

## TABLE X. — *Continued.*

| No. of Chart. | Date. 1854–55. | Long. of Sun. | Lat. of Obs. | *t.* | Elongation of Vertex. | | Lat. of Boundaries, Stronger Light. | | | | | | Lat. of Boundaries, Diffuse Light. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | | Elong. 60° | | Elong. 90° | | Elong. 120° | |
| | | | | | Str. | Diff. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. |
| 265 | Dec. 22 | 270° | 21.8° | 129° | 100° | 112° | ° | ° | 9° | 5° | 6° | 2° | 24° | 21° | 22° | 18° | ° | ° |
| 267 | Dec. 25 | 273 | 16.5 | 184 | | 162 | | | | | | | | | | | 8 | 10 |
| 273 | Jan. 5 | 285 | 8.8 | 120 | 91 | | 9 | 8 | 7 | 5 | 4 | 0 | 22 | 20 | 16 | 16 | 12 | 12 |
| | | | | 133 | 130 | | | | 7 | 12 | 5 | 9 | | | | | | |
| 274 | Jan. 6 | 286 | 8.8 | 121 | 94 | | 10 | 10 | 7 | 6 | 4 | 2 | 21 | 20 | 14 | 16 | 8 | 12 |
| | | | | 136 | 110 | | | | 7 | 10 | 4 | 6 | 21 | 20 | 14 | 16 | | |
| 275 | Jan. 8 | 288 | 8.8 | 127 | 98 | | 9 | 9 | 5 | 6 | 2 | 2 | 21 | 22 | 16 | 16 | | 10 |
| | | | | 133 | 102 | | | | 7 | 8 | 4 | 4 | | | | | | |
| | | | | 140 | 112 | | | | 7 | 11 | 4 | 6 | | | | | | |
| | | | | 145 | 122 | | | | 8 | 13 | 5 | 8 | | | | | | |
| 276 | Jan. 9 | 289 | 8.8 | 128 | 88 | | 9 | 10 | 6 | 6 | | | 19 | 22 | 11 | 19 | | |
| | | | | 139 | 96 | | | | 7 | 8 | 4 | 4 | | | | | | |
| | | | | 141 | 102 | | | | 7 | 11 | 4 | 6 | 19 | 22 | 11 | 19 | | |
| 277 | Jan. 10 | 290 | 8.8 | 131 | 94 | | 10 | 12 | 7 | 8 | 4 | 4 | 19 | 22 | 11 | 17 | | |
| | | | | 133 | 91 | | 8 | 9 | 6 | 6 | 2 | 2 | | | | | | |
| | | | | 136 | 94 | | | | 7 | 8 | 4 | 4 | | | | | | |
| | | | | 140 | 101 | | | | 7 | 10 | 4 | 5 | 19 | 22 | 11 | 17 | | |
| | | | | 155 | 115 | | | | 7 | 13 | 4 | 8 | | | | | | |
| 278 | Jan. 11 | 291 | 8.8 | 130 | | | | | | | | | 19 | 26 | 11 | 20 | 4 | 14 |
| | | | | 134 | 86 | | 9 | 9 | 5 | 5 | | | | | | | | |
| | | | | 136 | 96 | | | | 6 | 8 | 2 | 4 | | | | | | |
| | | | | 141 | 104 | | | | 8 | 10 | 3 | 6 | | | | | | |
| | | | | 156 | 118 | | | | 9 | 12 | 5 | 8 | 19 | 26 | 11 | 20 | 4 | 14 |
| 279 | Jan. 12 | 292 | 7.1 | 132 | | | | | | | | | 19 | 25 | 12 | 19 | 5 | 14 |
| | | | | 137 | 91 | | 8 | 10 | 5 | 7 | 1 | 2 | | | | | | |
| | | | | 140 | 99 | | 9 | 12 | 6 | 8 | 3 | 4 | | | | | | |
| | | | | 142 | 109 | | | | 7 | 10 | 4 | 6 | | | | | | |
| | | | | 146 | 109 | | | | 7 | 10 | 4 | 6 | 21 | 25 | 14 | 19 | 7 | 14 |
| 280 | Jan. 15 | 295 | 0.3 | 134 | 100 | | 8 | 18 | 5 | 11 | 2 | 6 | | | | | | |
| | | | | 137 | | | | | | | | | 17 | 23 | 10 | 18 | 4 | 12 |
| | | | | 145 | 107 | | | | 7 | 14 | 3 | 7 | | | | | | |
| | | | | 160 | 120 | | | | 8 | 16 | 4 | 9 | | | | | | |
| 281 | Jan. 17 | 297 | *2.9* | 140 | 98 | | | | 6 | 12 | 3 | 6 | 21 | 23 | 16 | 18 | 12 | 12 |
| | | | | 150 | 119 | | | | 7 | 15 | 4 | 8 | | | | | | |
| 283 | Jan. 18 | 298 | *5.1* | 140 | 92 | | 9 | 14 | 6 | 8 | 3 | 3 | | | | | | |
| | | | | 143 | 77 | | 7 | 10 | 4 | 5 | | | 13 | 23 | 10 | 18 | 6 | 12 |
| | | | | 146 | 100 | | 9 | 14 | 6 | 10 | 4 | 5 | | | | | | |
| | | | | 150 | 111 | | | | 6 | 12 | 4 | 7 | 13 | 23 | 10 | 18 | 6 | 12 |
| | | | | 163 | 123 | | | | | 14 | 5 | 10 | | | | | | |
| 285 | Jan. 20 | 300 | *9.9* | 161 | 120 | | | | 6 | 10 | 4 | 7 | 18 | 22 | 13 | 16 | 8 | 12 |
| | | | | 169 | 127 | | | | 6 | 15 | 4 | 10 | | | | | | |
| 289 | Feb. 6 | 317 | *33.0* | 174 | 110 | | | | 6 | 11 | 3 | 6 | | 26 | 13 | 20 | | 14 |
| | | | | 186 | 115 | | | | 6 | 14 | 3 | 8 | | | | | | |
| 290 | Feb. 7 | 318 | *33.0* | 173 | 110 | | | | 8 | 12 | 4 | 7 | | 24 | 14 | 18 | | 12 |
| | | | | 187 | 117 | | | | 8 | 14 | 4 | 9 | | 28 | 14 | 22 | | 16 |
| 291 | Feb. 8 | 319 | *33.0* | 173 | 110 | | | 20 | 6 | 14 | 3 | 8 | | 30 | 15 | 22 | | 14 |
| | | | | 188 | 117 | | | | 6 | 16 | 3 | 9 | | 35 | 15 | 27 | | 20 |
| 292 | Feb. 9 | 320 | *33.0* | 174 | 108 | | | 19 | 6 | 13 | 3 | 7 | | 28 | 14 | 22 | | 16 |
| | | | | 189 | 112 | | | 26 | 6 | 16 | 3 | 9 | | 36 | 14 | 28 | | 20 |
| 293 | Feb. 12 | 323 | *35.7* | 184 | 108 | | | | 4 | 13 | 2 | 8 | | 28 | | 22 | | 14 |
| 294 | Feb. 19 | 330 | *52.0* | 190 | 102 | | | | | | *4* | 10 | | | | 25 | | 24 |

## TABLE X. — *Continued.*

| No. of Chart. | Date. 1855. | Long. of Sun. | Lat. of Obs. | t. | Elongation of Vertex. | | Lat. of Boundaries, Stronger Light. | | | | | | Lat. of Boundaries, Diffuse Light. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | | Elong. 60° | | Elong. 90° | | Elong. 120° | |
| | | | | | Str. | Diff. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 295 | Feb. 21 | 332 | *53.6* | 196 | 101 | | | | | | *3* | 11 | | | | 25 | | |
| | | | | 204 | 108 | | | | | | *3* | 12 | | | | 29 | | |
| 300 | Mar. 13 | 353 | *22.9* | 193 | 79 | | | 11 | 4 | 7 | | | 13 | 23 | | 17 | | |
| | | | | 201 | 81 | | | 15 | 3 | 9 | | | | | | | | |
| | | | | 208 | | | | | 3 | 11 | | | | 36 | | 23 | | |
| 301 | Mar. 15 | 355 | *22.9* | 195 | 78 | | | 10 | 2 | 7 | | | | 22 | | 16 | | |
| | | | | 208 | | | | | 3 | 11 | | | 12 | 26 | | 20 | | |
| 303 | Mar. 16 | 356 | *22.9* | 196 | 74 | | | 14 | 2 | 8 | | | 12 | 22 | | 16 | | |
| | | | | 204 | 78 | | | | 2 | 10 | | | 12 | 36 | | 19 | | |
| | | | | 212 | | | | | | 13 | | | | 36 | | 19 | | |
| 305 | Mar. 17 | 357 | *22.9* | 197 | 74 | | | 14 | 2 | 8 | | | 14 | 24 | | 16 | | |
| | | | | 201 | 77 | | | | 2 | 9 | | | | | | | | |
| | | | | 205 | 77 | | | | 2 | 10 | | | | 26 | | 20 | | |
| | | | | 212 | | | | | | 12 | | | | | | | | |
| 308 | Mar. 21 | 0 | *22.9* | 216 | | | | | 3 | 9 | | | | 22 | | | | |
| | | | | 224 | | | | | | | | | | 22 | | | | |
| 314 | Apr. 4 | 14 | 1.6 | 211 | | | | 18 | | 9 | | | | 25 | | | | |
| 315 | Apr. 9 | 19 | 11.2 | 220 | 92 | | 8 | 11 | 7 | 6 | 6 | 0 | | 18 | | | | |
| | | | | 228 | 107 | 126 | | | 7 | 8 | 7 | 3 | 21 | 23 | 19 | 16 | 14 | 6 |
| | | | | 239 | 114 | | | | 7 | 10 | 7 | 5 | 21 | 23 | 19 | 16 | | 8 |
| | | | | 256 | 131 | | | | 9 | 14 | 8 | 7 | 21 | 23 | 19 | 17 | 18 | 10 |
| 316 | Apr. 10 | 20 | 13.1 | 219 | 88 | | 9 | 13 | 8 | 5 | | | | | | | | |
| | | | | 234 | 109 | 134 | | | 10 | 10 | 9 | 3 | 18 | 23 | 17 | 16 | 16 | 8 |
| | | | | 254 | 129 | | | | 10 | 14 | 9 | 8 | 18 | 23 | 17 | 16 | 16 | 8 |
| | | | | 268 | | | | | | | | | 18 | 23 | 17 | 16 | 16 | 8 |
| 317 | Apr. 11 | 21 | 15.2 | 221 | 92 | | 9 | 12 | 8 | 6 | 6 | *2* | | 23 | | 14 | | 5 |
| | | | | 241 | 112 | | | | 9 | 10 | 8 | 4 | 29 | 26 | 28 | 16 | 27 | 8 |
| 319 | Apr. 13 | 23 | 20.1 | 224 | 99 | | 9 | 14 | 7 | 8 | 5 | 2 | | | | | | |
| | | | | 239 | 126 | | | | 10 | 12 | 8 | 8 | 28 | 25 | 26 | 16 | 24 | 7 |
| | | | | 254 | | | | | 11 | 14 | 9 | 9 | 28 | 26 | 26 | 18 | 24 | 9 |
| 321 | Apr. 14 | 24 | 22.5 | 233 | 116 | | | | 9 | 9 | 7 | 4 | 26 | 26 | 22 | 17 | 20 | 8 |
| | | | | 248 | 130 | | | | 13 | 10 | 10 | 6 | 26 | 28 | 22 | 19 | 20 | 10 |
| | | | | 255 | 132 | | | | 18 | 10 | 13 | 6 | | | | | | |
| 323 | Apr. 16 | 26 | 27.1 | 231 | 108 | | 14 | 12 | 10 | 8 | 6 | 5 | 34 | 26 | 30 | 18 | 26 | 10 |
| | | | | 246 | 122 | | 20 | 14 | 15 | 10 | 9 | 8 | 34 | 26 | 30 | 18 | 26 | 10 |
| | | | | 261 | | | | | 17 | 12 | 12 | 9 | | | | | | |
| 326 | Apr. 18 | 28 | 32.2 | 252 | 124 | | | | 15 | 7 | 10 | 5 | 36 | 18 | 31 | 16 | 26 | 12 |
| | | | | 267 | 142 | | | | 17 | 11 | 12 | 9 | | | | | | |

TABLE XI. — EVENING OBSERVATIONS: HEIS, WEBER, EYLERT, NEUMAYER.

| No. | Observer. | Date. | | Long. of Sun. | Lat. of Obs. | t. | Elong. of Vert. | Lat. of Boundaries. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | |
| | | | | | | | | N. | S. | N. | S. | N. | S. |
| | | | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 1 | Heis | 1847 | Mar. 14 | 354 | 50.8 | 202 | 55 | 11 | 9 | | | | |
| 2 | " | 1847 | Mar. 15 | 355 | " | 203 | 58 | 11 | 9 | | | | |
| 3 | " | 1847 | Mar. 16 | 355 | " | 204 | 62 | 21 | 10 | 5 | 2 | | |
| 4 | " | 1847 | Mar. 17 | 356 | " | 205 | 62 | 21 | 10 | 5 | 2 | | |
| 5 | " | 1847 | Mar. 18 | 357 | " | 206 | 62 | 23 | 12 | 6 | 1 | | |
| 6 | " | 1848 | Mar. 24 | 3 | " | 212 | 54 | 8 | 14 | | | | |
| 7 | " | 1849 | Jan. 22 | 302 | " | 152 | 82 | | | 7 | 14 | | |
| 8 | " | 1849 | Feb. 13 | 324 | " | 174 | 84 | | | 10 | 12 | | |
| 9 | " | 1849 | Mar. 19 | 358 | " | 207 | 67 | 17 | 13 | 1 | 8 | | |
| 10 | " | 1849 | Mar. 20 | 359 | " | 208 | 64 | 10 | 12 | 7 | 6 | | |
| 11 | " | 1850 | Mar. 5 | 345 | " | 186 | 62 | 12 | 15 | 7 | 5 | | |
| 12 | " | 1850 | Mar. 9 | 349 | " | 193 | 61 | 21 | 5 | 5 | 0 | | |
| 13 | " | 1850 | Mar. 13 | 353 | " | 208 | 62 | 23 | 5 | 7 | *1* | | |
| 14 | " | 1850 | Mar. 15 | 355 | " | 203 | 62 | 24 | 5 | 6 | *1* | | |
| 15 | " | 1851 | Jan. 23 | 303 | " | 138 | 72 | | | 11 | 3 | | |
| 16 | " | 1851 | Feb. 18 | 329 | " | 163 | 78 | 17 | 17 | 8 | 8 | | |
| 17 | " | 1851 | Feb. 23 | 334 | " | 183 | 77 | 11 | 15 | 5 | 5 | | |
| 18 | " | 1851 | April 1 | 11 | " | 220 | 57 | 12 | 10 | | | | |
| 19 | " | 1851 | Dec. 18 | 266 | " | 102 | 78 | 11 | | 7 | 5 | | |
| 20 | " | 1851 | Dec. 23 | 271 | " | 107 | 80 | 35 | 12 | 23 | 7 | | |
| 21 | " | 1852 | Jan. 10 | 290 | " | 117 | 70 | 20 | 11 | 13 | 2 | | |
| 22 | " | 1852 | Jan. 19 | 299 | " | 134 | 90 | | | 18 | 11 | | |
| 23 | " | 1852 | Jan. 20 | 300 | " | 135 | 90 | 30 | | 18 | 7 | | |
| 24 | " | 1852 | Mar. 19 | 358 | " | 214 | 58 | 17 | 13 | | | | |
| 25 | " | 1852 | Mar. 20 | 359 | " | 216 | 56 | 24 | 11 | | | | |
| 26 | " | 1852 | Dec. 11 | 259 | 52.0 | 110 | 81 | | | 19 | 7 | | |
| 27 | " | 1853 | Jan. 3 | 283 | " | 118 | 78 | | | 16 | 3 | | |
| 28 | " | 1853 | Jan. 4 | 284 | " | 112 | 74 | | | 14 | 3 | | |
| 29 | " | 1853 | Jan. 27 | 307 | " | 135 | 80 | 26 | 15 | 13 | 8 | | |
| 30 | " | 1853 | Jan. 29 | 309 | " | 144 | 85 | | | 12 | 11 | | |
| 31 | " | 1853 | Feb. 28 | 339 | " | 192 | 69 | | | 8 | 4 | | |
| 32 | " | 1853 | Mar. 1 | 341 | " | 189 | 68 | 12 | 12 | 7 | 2 | | |
| 33 | " | 1853 | Mar. 11 | 351 | " | 206 | 66 | 24 | 11 | 8 | 0 | | |
| 34 | " | 1853 | Mar. 27 | 6 | " | 223 | 50 | 22 | 4 | | | | |
| 35 | " | 1853 | Mar. 28 | 7 | " | 216 | 54 | 19 | 9 | | | | |
| 36 | " | 1853 | Mar 30 | 9 | " | 218 | 56 | 19 | 8 | | | | |
| 37 | " | 1853 | April 28 | 38 | " | 266 | 60 | 14 | 9 | | | | |
| 38 | " | 1853 | May 4 | 43 | " | 274 | 62 | 24 | | 10 | *2* | | |
| 39 | " | 1853 | Aug. 9 | 137 | " | 33 | 96 | | | 18 | 4 | | |
| 40 | " | 1853 | Dec. 1 | 249 | " | 78 | 86 | | | 19 | 5 | | |
| 41 | " | 1853 | Dec. 2 | 250 | " | 78 | 94 | | | 12 | 8 | 7 | 1 |
| 42 | " | 1853 | Dec. 25 | 273 | " | 94 | 83 | | | 12 | 15 | | |
| 43 | " | 1854 | Jan. 18 | 298 | " | 133 | 86 | 27 | 15 | 14 | 8 | | |
| 44 | " | 1854 | Jan. 19 | 299 | " | 126 | 76 | 22 | | 10 | 8 | | |
| 45 | " | 1854 | Jan. 24 | 304 | " | 154 | 84 | | | 10 | 11 | | |
| 46 | " | 1854 | Feb. 28 | 339 | " | 199 | 77 | | | 12 | 8 | | |
| 47 | " | 1854 | Mar. 16 | 355 | " | 204 | 65 | 30 | 7 | 7 | 3 | | |
| 48 | " | 1854 | Mar. 18 | 357 | " | 206 | 64 | 26 | 11 | 6 | 2 | | |
| 49 | " | 1854 | April 16 | 26 | " | 250 | 61 | 18 | 6 | | | | |
| 50 | " | 1854 | April 17 | 27 | " | 266 | 62 | 21 | 9 | | | | |
| 51 | " | 1854 | April 18 | 28 | " | 267 | 73 | 26 | 18 | 14 | 6 | | |
| 52 | " | 1855 | Jan. 10 | 290 | " | 125 | 70 | 18 | 12 | 10 | 5 | | |

## TABLE XI. — *Continued.*

| No. | Observer. | Date. | | Long. of Sun. | Lat. of Obs. | *t.* | Elong. of Vert. | Lat. of Boundaries. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | |
| | | | | | | | | N. | S. | N. | S. | N. | S. |
| | | | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 53 | Heis | 1855 | Jan. 18 | 298 | 52.0 | 148 | 96 | | | 19 | 16 | | |
| 54 | " | 1855 | Feb. 9 | 320 | " | 170 | 86 | | | 13 | 11 | | |
| 55 | " | 1855 | Feb. 16 | 327 | " | 176 | 87 | 28 | 11 | 13 | 7 | | |
| 56 | " | 1855 | Mar. 5 | 345 | " | 193 | 73 | | | 11 | 4 | | |
| 57 | " | 1855 | Mar. 16 | 355 | " | 204 | 72 | 25 | 15 | 11 | 4 | | |
| 58 | " | 1855 | July 22 | 119 | " | 30 | 94 | 43 | | 32 | | 12 | |
| 59 | " | 1856 | Feb. 3 | 314 | " | 149 | 89 | | | 13 | 11 | | |
| 60 | " | 1856 | Mar. 7 | 347 | " | 195 | 69 | 28 | 10 | 8 | 5 | | |
| 61 | " | 1856 | Mar. 25 | 4 | " | 220 | 67 | 15 | 19 | 5 | 7 | | |
| 62 | " | 1856 | April 23 | 33 | " | 265 | 65 | 20 | 13 | | | | |
| 63 | " | 1857 | Feb. 14 | 325 | " | 174 | 82 | | | 20 | 7 | | |
| 64 | " | 1857 | Feb. 15 | 326 | " | 175 | 80 | 30 | 17 | 17 | 8 | | |
| 65 | " | 1857 | Feb. 23 | 334 | " | 168 | 74 | | | 13 | 8 | | |
| 66 | " | 1857 | Feb. 24 | 335 | " | 169 | 78 | | | 16 | 8 | | |
| 67 | " | 1857 | Mar. 16 | 355 | " | 196 | 74 | 35 | 17 | 15 | 13 | | |
| 68 | " | 1857 | Mar. 17 | 356 | " | 205 | 74 | | | 11 | 11 | | |
| 69 | " | 1857 | April 15 | 25 | " | 249 | 59 | 20 | 15 | | | | |
| 70 | " | 1857 | Dec. 8 | 256 | " | 107 | 101 | | | 14 | 17 | 10 | 6 |
| 71 | " | 1857 | Dec. 18 | 266 | " | 117 | 82 | 38 | 8 | 30 | 5 | | |
| 72 | " | 1858 | Jan. 3 | 283 | " | 118 | 89 | 20 | | 13 | 12 | | |
| 73 | " | 1858 | Feb. 7 | 318 | " | 153 | 76 | 21 | 13 | 9 | 8 | | |
| 74 | " | 1858 | Mar. 5 | 345 | " | 193 | 70 | 24 | | 10 | 8 | | |
| 75 | " | 1858 | April 4 | 14 | " | 223 | 58 | 18 | 13 | | | | |
| 76 | " | 1858 | April 14 | 24 | " | 240 | 80 | 17 | 9 | 8 | 4 | | |
| 77 | " | 1859 | Jan. 5 | 285 | " | 120 | 85 | | | 15 | 15 | | |
| 78 | " | 1859 | Jan. 22 | 302 | " | 144 | 111 | | | 16 | 12 | | |
| 79 | " | 1859 | Jan. 27 | 307 | " | 142 | 106 | | | 16 | 14 | 9 | 4 |
| 80 | " | 1859 | Mar. 7 | 347 | " | 210 | 74 | | | 16 | 8 | | |
| 81 | " | 1859 | Mar. 22 | 1 | " | 210 | 65 | 24 | | 10 | 0 | | |
| 82 | " | 1859 | Mar. 28 | 7 | " | 216 | 61 | 26 | 17 | | | | |
| 83 | " | 1859 | Nov. 20 | 238 | " | 90 | 85 | | | 8 | 2 | | |
| 84 | " | 1859 | Dec. 20 | 268 | " | 104 | 70 | 21 | 8 | 8 | 3 | | |
| 85 | " | 1860 | Jan. 12 | 292 | " | 127 | 88 | 25 | | 14 | 7 | | |
| 86 | " | 1860 | Feb. 9 | 320 | " | 162 | 88 | 16 | 9 | 9 | 6 | | |
| 87 | " | 1860 | Feb. 11 | 322 | " | 157 | 92 | | | 12 | 11 | 4 | 0 |
| 88 | " | 1860 | Feb. 15 | 326 | " | 171 | 89 | 29 | | 17 | 8 | | |
| 89 | " | 1860 | Feb. 23 | 334 | " | 175 | 88 | | | 17 | 7 | | |
| 90 | " | 1860 | April 7 | 17 | " | 234 | 66 | 25 | | 6 | 2 | | |
| 91 | " | 1861 | Jan. 1 | 281 | " | 116 | 67 | 16 | | 8 | 1 | | |
| 92 | " | 1861 | Jan. 8 | 288 | " | 116 | 73 | 25 | 11 | 13 | 1 | | |
| 93 | " | 1861 | Jan. 9 | 289 | " | 124 | 78 | | | 16 | 4 | | |
| 94 | " | 1861 | Feb. 2 | 313 | " | 163 | 71 | 22 | 13 | 8 | 7 | | |
| 95 | " | 1861 | Feb. 10 | 321 | " | 171 | 85 | | | 13 | 9 | | |
| 96 | " | 1861 | Mar. 9 | 349 | " | 197 | 72 | 24 | 11 | 10 | 2 | | |
| 97 | " | 1861 | Mar. 12 | 352 | " | 189 | 80 | 22 | 15 | 12 | 6 | | |
| 98 | " | 1861 | April 6 | 16 | " | 240 | 73 | 25 | 18 | 9 | 12 | | |
| 99 | " | 1861 | April 9 | 19 | " | 243 | 70 | 25 | 9 | 8 | 4 | | |
| 100 | " | 1862 | Feb. 18 | 329 | " | 178 | 79 | | | 13 | 7 | | |
| 101 | " | 1862 | Feb. 22 | 333 | " | 182 | 80 | 24 | 17 | 13 | 8 | | |
| 102 | " | 1862 | Mar. 17 | 356 | " | 205 | 63 | 23 | 11 | | | | |
| 103 | " | 1862 | Mar. 27 | 6 | " | 215 | 57 | 23 | 13 | | | | |
| 104 | " | 1862 | Mar. 31 | 10 | " | 226 | 57 | 26 | 14 | | | | |

## TABLE XI. — *Continued.*

| No. | Observer. | Date. | | Long. of Sun. | Lat. of Obs. | *t*. | Elong. of Vert. | Lat. of Boundaries. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | |
| | | | | | | | | N. | S. | N. | S. | N. | S. |
| | | | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 105 | Heis | 1862 | April 25 | 35 | 52.0 | 259 | 77 | | | 9 | 4 | | |
| 106 | " | 1862 | April 29 | 39 | " | 263 | 80 | 22 | 8 | 11 | 5 | | |
| 107 | " | 1862 | Dec. 16 | 264 | " | 85 | 95 | | | 15 | 8 | | |
| 108 | " | 1862 | Dec. 22 | 270 | " | 95 | 78 | 26 | 6 | 18 | 5 | | |
| 109 | " | 1863 | Jan. 9 | 289 | " | 120 | 94 | | | 21 | 6 | 4 | 2 |
| 110 | " | 1863 | Jan. 15 | 295 | " | 122 | 86 | | | 13 | 5 | | |
| 111 | " | 1863 | Feb. 5 | 316 | " | 151 | 70 | | | 13 | 6 | | |
| 112 | " | 1863 | Feb. 9 | 320 | " | 170 | 86 | | | 12 | 12 | | |
| 113 | " | 1863 | Feb. 14 | 325 | " | 174 | 86 | | | 12 | 10 | | |
| 114 | " | 1863 | Feb. 17 | 328 | " | 177 | 87 | | | 16 | 10 | | |
| 115 | " | 1863 | Mar. 8 | 348 | " | 196 | 80 | 28 | 14 | 12 | 6 | | |
| 116 | " | 1863 | April 6 | 16 | " | 244 | 77 | | | 11 | 7 | | |
| 117 | " | 1863 | April 10 | 20 | " | 244 | 76 | | | 11 | 7 | | |
| 118 | " | 1863 | April 13 | 23 | " | 243 | 74 | 26 | 19 | 15 | 6 | | |
| 119 | " | 1863 | April 19 | 29 | " | 253 | 70 | 25 | | 13 | 10 | | |
| 120 | " | 1864 | Jan. 4 | 284 | " | 126 | 88 | | | 15 | 8 | | |
| 121 | " | 1864 | Jan. 10 | 290 | " | 125 | 95 | | | 18 | 12 | 2 | 6 |
| 122 | " | 1864 | Jan. 26 | 306 | " | 134 | 84 | | | 12 | 11 | | |
| 123 | " | 1864 | Jan. 30 | 310 | " | 137 | 97 | | | 15 | 11 | | |
| 124 | " | 1864 | Feb. 28 | 339 | " | 192 | 87 | | | 17 | 9 | | |
| 125 | " | 1864 | Mar. 10 | 350 | " | 205 | 84 | | | 11 | 13 | | |
| 126 | " | 1864 | Mar. 29 | 8 | " | 217 | 64 | 21 | 12 | 5 | 0 | | |
| 127 | " | 1864 | April 2 | 12 | " | 228 | 64 | 20 | 13 | 2 | 1 | | |
| 128 | " | 1864 | April 5 | 15 | " | 232 | 74 | | | 10 | 6 | | |
| 129 | " | 1864 | April 6 | 16 | " | 232 | 74 | | | 10 | 5 | | |
| 130 | " | 1864 | April 8 | 18 | " | 242 | 73 | 24 | 10 | 9 | 6 | | |
| 131 | " | 1864 | April 24 | 34 | " | 265 | 80 | | | 13 | 13 | | |
| 132 | " | 1864 | April 30 | 39 | " | 270 | 76 | 21 | | 11 | 4 | | |
| 133 | " | 1864 | May 3 | 42 | " | 277 | 78 | | | 14 | 7 | | |
| 134 | " | 1864 | May 8 | 47 | " | 294 | 75 | 18 | | 9 | 10 | | |
| 135 | " | 1864 | Dec. 26 | 274 | " | 102 | 80 | 34 | 12 | 21 | 2 | | |
| 136 | " | 1865 | Jan. 28 | 308 | " | 136 | 95 | | | 18 | 7 | 1 | 3 |
| 137 | " | 1865 | Feb. 14 | 325 | " | 174 | 84 | | | 19 | 6 | | |
| 138 | " | 1865 | Feb. 22 | 333 | " | 167 | 86 | | | 18 | 10 | | |
| 139 | " | 1865 | Mar. 19 | 358 | " | 207 | 77 | 21 | 15 | 8 | 8 | | |
| 140 | " | 1865 | April 20 | 30 | " | 250 | 71 | | | 9 | 5 | | |
| 141 | " | 1865 | April 22 | 32 | " | 256 | 73 | 20 | 15 | 13 | 8 | | |
| 142 | " | 1865 | April 24 | 34 | " | 258 | 73 | | | 15 | 2 | | |
| 143 | " | 1865 | Dec. 15 | 263 | " | 114 | 94 | | | 17 | 9 | | |
| 144 | " | 1866 | Jan. 5 | 285 | " | 135 | 94 | 19 | 10 | 13 | 7 | 2 | 1 |
| 145 | " | 1866 | Feb. 8 | 319 | " | 169 | 89 | | | 14 | 14 | | |
| 146 | " | 1866 | Feb. 11 | 322 | " | 180 | 91 | | | 14 | 10 | | |
| 147 | " | 1866 | Mar. 3 | 343 | " | 187 | 68 | 26 | 12 | 8 | 3 | | |
| 148 | " | 1866 | Dec. 30 | 279 | " | 114 | 71 | 26 | 3 | 16 | 2 | | |
| 149 | " | 1867 | Jan. 5 | 285 | " | 112 | 81 | | | 14 | 14 | | |
| 150 | " | 1867 | Feb. 1 | 312 | " | 147 | 90 | | | 11 | 11 | | |
| 151 | " | 1867 | Feb. 2 | 313 | " | 148 | 97 | | | 27 | 11 | 8 | 0 |
| 152 | " | 1867 | Feb. 23 | 334 | " | 172 | 81 | 26 | | 14 | 5 | | |
| 153 | " | 1867 | Feb. 26 | 337 | " | 186 | 89 | | | 16 | 6 | | |
| 154 | " | 1867 | Mar. 2 | 342 | " | 190 | 87 | | | 17 | 7 | | |
| 155 | " | 1867 | April 1 | 11 | " | 224 | 75 | | | 8 | 5 | | |
| 156 | " | 1867 | Dec. 24 | 272 | " | 100 | 88 | | | 13 | 7 | | |

## TABLE XI. — *Continued.*

| No. | Observer. | Date. | | Long. of Sun. | Lat. of Obs. | *t*. | Elong. of Vert. | Lat. of Boundaries. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | |
| | | | | | | | | N. | S. | N. | S. | N. | S. |
| 157 | Heis | 1868 | Jan. 20 | 300° | 52°.0 | 150° | 97° | ° | ° | 23° | 15° | 13° | *3*° |
| 158 | " | 1868 | Feb. 11 | 322 | " | 172 | 93 | | | 29 | 5 | 10 | *2* |
| 159 | " | 1868 | Feb. 17 | 328 | " | 177 | 92 | | | 20 | 9 | | |
| 160 | " | 1868 | Mar. 25 | 4 | " | 228 | 78 | | | 12 | 8 | | |
| 161 | " | 1869 | Jan. 8 | 288 | " | 123 | 94 | 24 | 10 | 16 | 6 | 3 | 2 |
| 162 | " | 1869 | Feb. 5 | 316 | " | 159 | 93 | | | 13 | 11 | | |
| 163 | " | 1869 | Mar. 5 | 345 | " | 193 | 82 | | | 15 | 9 | | |
| 164 | " | 1870 | Jan. 25 | 305 | " | 140 | 101 | | | 16 | 15 | 7 | 4 |
| 165 | " | 1870 | Jan. 30 | 310 | " | 145 | 99 | | | 16 | 9 | 4 | 4 |
| 166 | " | 1870 | Feb. 22 | 333 | " | 182 | 80 | | | 18 | 2 | | |
| 167 | " | 1870 | Feb. 27 | 338 | " | 187 | 78 | | | 15 | 8 | | |
| 168 | " | 1870 | Mar. 3 | 343 | " | 191 | 77 | | | 14 | 9 | | |
| 169 | " | 1870 | Mar. 6 | 346 | " | 239 | 75 | | | 13 | 7 | | |
| 170 | " | 1870 | April 1 | 11 | " | 227 | 65 | 23 | 16 | 5 | 3 | | |
| 171 | " | 1870 | April 2 | 12 | " | 228 | 71 | | | 9 | 2 | | |
| 172 | " | 1870 | Dec. 11 | 259 | " | 95 | 80 | | | 10 | 12 | | |
| 173 | " | 1871 | Jan. 15 | 295 | " | 130 | 104 | | | 19 | 13 | | |
| 174 | " | 1872 | Mar. 4 | 344 | " | 192 | 76 | | | 12 | 3 | | |
| 175 | " | 1872 | Mar. 11 | 351 | " | 206 | 72 | 25 | 17 | 10 | 4 | | |
| 176 | " | 1874 | Feb. 5 | 316 | " | 151 | 93 | | | 16 | 11 | | |
| 177 | " | 1874 | Feb. 11 | 322 | " | 157 | 89 | | | 14 | 9 | | |
| 178 | " | 1874 | Feb. 13 | 324 | " | 173 | 90 | | | 14 | 4 | | |
| 179 | " | 1875 | Jan. 7 | 287 | " | 137 | 117 | | | | | 9 | 11 |
| 180 | " | 1875 | Jan. 27 | 307 | " | 120 | 103 | | | 14 | 17 | 5 | 5 |
| 181 | " | 1875 | Feb. 5 | 316 | " | 155 | 96 | | | 15 | 15 | 4 | 3 |
| 182 | " | 1875 | Feb. 23 | 334 | " | 183 | 94 | | | 13 | 11 | | |
| 183 | " | 1875 | Mar. 3 | 343 | " | 191 | 89 | | | 12 | 8 | | |
| 184 | " | 1875 | Mar. 4 | 344 | " | 192 | 95 | 27 | 15 | 12 | 11 | 2 | 2 |
| 185 | " | 1875 | Mar. 5 | 345 | " | 193 | 95 | 25 | 13 | 16 | 10 | 7 | 0 |
| 186 | Weber | 1865 | April 20 | 30 | " | 254 | 79 | 15 | | 8 | 9 | | |
| 187 | " | 1865 | April 21 | 31 | " | 255 | 81 | | | 11 | 10 | | |
| 188 | " | 1865 | April 23 | 33 | " | 257 | 79 | | | 14 | 6 | | |
| 189 | " | 1865 | April 27 | 37 | " | 261 | 80 | | | 14 | 4 | | |
| 190 | " | 1866 | Jan. 5 | 285 | " | 135 | 74 | 22 | 8 | 11 | 3 | | |
| 191 | " | 1866 | Mar. 4 | 344 | " | 207 | 82 | 17 | 14 | 8 | 5 | | |
| 192 | " | 1866 | Mar. 5 | 345 | " | 193 | 82 | 18 | 15 | 7 | 5 | | |
| 193 | " | 1866 | Dec. 30 | 278 | " | 106 | 64 | | | 2 | 5 | | |
| 194 | " | 1867 | Feb. 2 | 313 | " | 163 | 76 | | | 10 | 9 | | |
| 195 | " | 1867 | Feb. 3 | 314 | " | 164 | 76 | 24 | 24 | 11 | 8 | | |
| 196 | " | 1867 | Feb. 23 | 334 | " | 183 | 84 | 22 | 20 | 9 | 6 | | |
| 197 | " | 1867 | Feb. 26 | 337 | " | 186 | 83 | 22 | 15 | 10 | 5 | | |
| 198 | " | 1867 | Mar. 2 | 342 | " | 190 | 79 | 20 | 14 | 7 | 4 | | |
| 199 | " | 1867 | Mar. 25 | 4 | " | 213 | 72 | 19 | 17 | 10 | 6 | | |
| 200 | " | 1867 | Mar. 26 | 5 | " | 214 | 73 | 22 | 14 | 9 | 5 | | |
| 201 | " | 1867 | Mar. 29 | 8 | " | 217 | 70 | 22 | 7 | 5 | 2 | | |
| 202 | " | 1867 | Mar. 30 | 9 | " | 218 | 69 | 20 | 10 | 5 | 2 | | |
| 203 | " | 1867 | April 25 | 35 | " | 252 | 65 | 21 | 13 | | | | |
| 204 | " | 1867 | May 5 | 44 | " | 268 | 65 | 18 | 14 | 7 | *1* | | |
| 205 | " | 1869 | Jan. 11 | 291 | " | 141 | 78 | 23 | 9 | 14 | 2 | | |
| 206 | " | 1869 | Jan. 12 | 292 | " | 142 | 79 | | | 13 | 1 | | |
| 207 | " | 1869 | Jan. 13 | 293 | " | 143 | 77 | | | 12 | 2 | | |
| 208 | " | 1869 | Feb. 5 | 316 | " | 166 | 84 | 25 | 17 | 13 | 9 | | |

TABLE XI. — *Continued.*

| No. | Observer. | Date. | | Long. of Sun. | Lat. of Obs. | t. | Elong. of Vert. | Lat. of Boundaries. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | |
| | | | | | | | | N. | S. | N. | S. | N. | S. |
| | | | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 209 | Weber | 1869 | Feb. 6 | 317 | 52.0 | 167 | 84 | 24 | 18 | 14 | 8 | | |
| 210 | " | 1869 | Feb. 14 | 325 | " | 174 | 82 | 26 | 7 | 14 | 2 | | |
| 211 | " | 1869 | Mar. 3 | 343 | " | 191 | 87 | | | 12 | 8 | | |
| 212 | " | 1869 | Mar. 8 | 348 | " | 196 | 82 | | | 12 | 6 | | |
| 213 | " | 1869 | Mar. 30 | 9 | " | 226 | 77 | 19 | 11 | 9 | 4 | | |
| 214 | " | 1869 | Mar. 31 | 10 | " | 226 | 76 | 20 | 12 | 8 | 4 | | |
| 215 | " | 1869 | April 1 | 11 | " | 228 | 76 | 19 | 12 | 8 | 5 | | |
| 216 | " | 1869 | April 5 | 15 | " | 231 | 75 | 20 | 11 | 8 | 4 | | |
| 217 | " | 1869 | April 11 | 21 | " | 238 | 70 | 19 | 8 | 9 | 0 | | |
| 218 | " | 1870 | Jan. 25 | 305 | " | 155 | 88 | | | 12 | 6 | | |
| 219 | " | 1870 | Jan. 28 | 308 | " | 158 | 86 | 24 | 10 | 11 | 5 | | |
| 220 | " | 1870 | Jan. 31 | 311 | " | 146 | 86 | | | 12 | 7 | | |
| 221 | " | 1870 | Feb. 22 | 333 | " | 182 | 87 | | | 12 | 6 | | |
| 222 | " | 1870 | Feb. 27 | 338 | " | 187 | 89 | | | 14 | 6 | | |
| 223 | " | 1870 | Feb. 28 | 339 | " | 188 | 87 | | | 11 | 4 | | |
| 224 | " | 1870 | Mar. 2 | 342 | " | 190 | 87 | | | 13 | 2 | | |
| 225 | " | 1870 | Mar. 3 | 343 | " | 183 | 87 | | | 13 | 4 | | |
| 226 | " | 1870 | Mar. 5 | 345 | " | 193 | 87 | 25 | 14 | 12 | 2 | | |
| 227 | " | 1870 | Mar. 19 | 358 | " | 207 | 86 | 19 | 11 | 9 | 2 | | |
| 228 | " | 1870 | April 1 | 11 | " | 220 | 84 | | | 10 | 6 | | |
| 229 | " | 1870 | April 3 | 13 | " | 222 | 80 | | | 10 | 8 | | |
| 230 | " | 1870 | April 20 | 30 | " | 239 | 78 | | | 10 | 8 | | |
| 231 | " | 1870 | April 22 | 32 | " | 241 | 80 | | | 9 | 7 | | |
| 232 | " | 1870 | Dec. 21 | 269 | " | 105 | 100 | | | 19 | 10 | 4 | 5 |
| 233 | " | 1871 | Jan. 13 | 293 | " | 128 | 91 | | | 16 | 12 | | |
| 234 | " | 1871 | Jan. 15 | 295 | " | 122 | 91 | | | 19 | 11 | | |
| 235 | " | 1871 | Mar. 12 | 352 | " | 200 | 85 | | | 9 | 11 | | |
| 236 | " | 1871 | Mar. 19 | 358 | " | 207 | 82 | | | 5 | 7 | | |
| 237 | " | 1871 | Mar. 22 | 1 | " | 210 | 79 | 18 | 20 | 8 | 8 | | |
| 238 | " | 1871 | April 8 | 18 | " | 235 | 88 | | | 10 | 6 | | |
| 239 | " | 1871 | April 14 | 24 | " | 240 | 87 | | | 9 | 9 | | |
| 240 | " | 1873 | Jan. 25 | 305 | " | 132 | 88 | | | 17 | 13 | | |
| 241 | " | 1873 | Jan. 26 | 306 | " | 133 | 89 | | | 16 | 13 | | |
| 242 | " | 1873 | Feb. 21 | 332 | " | 166 | 88 | | | 11 | 7 | | |
| 243 | " | 1873 | Feb. 27 | 338 | " | 191 | 90 | | | 11 | 12 | | |
| 244 | " | 1873 | Mar. 21 | 0 | " | 209 | 99 | | | 13 | 13 | 4 | 5 |
| 245 | " | 1873 | Mar. 24 | 3 | " | 212 | 99 | 24 | 20 | 13 | 12 | 2 | 3 |
| 246 | " | 1873 | Mar. 27 | 6 | " | 215 | 99 | 25 | 19 | 14 | 14 | 3 | 6 |
| 247 | " | 1873 | April 20 | 30 | " | 239 | 92 | | | 18 | 7 | 5 | 0 |
| 248 | " | 1874 | Jan. 7 | 287 | " | 137 | 90 | | | 12 | 10 | | |
| 249 | " | 1874 | Feb. 5 | 316 | " | 147 | 93 | | | 11 | 4 | | |
| 250 | " | 1874 | Feb. 8 | 319 | " | 154 | 95 | 21 | 16 | 10 | 9 | 3 | 1 |
| 251 | " | 1874 | Feb. 9 | 320 | " | 159 | 96 | | | 12 | 7 | 4 | 1 |
| 252 | " | 1874 | Mar. 5 | 345 | " | 189 | 91 | 21 | 14 | 9 | 9 | | |
| 253 | " | 1874 | Mar. 6 | 346 | " | 190 | 93 | | | 9 | 8 | 2 | 0 |
| 254 | " | 1874 | Mar. 9 | 349 | " | 197 | 89 | | | 11 | 8 | | |
| 255 | " | 1874 | April 4 | 14 | " | 238 | 96 | | | 14 | 10 | 5 | 1 |
| 256 | " | 1874 | April 12 | 22 | " | 238 | 109 | | | 17 | 10 | 10 | 4 |
| 257 | " | 1874 | April 17 | 27 | " | 251 | 110 | | | 17 | 10 | 12 | 4 |
| 258 | " | 1874 | Dec. 2 | 250 | " | 71 | 115 | | | | | 13 | 6 |
| 259 | " | 1874 | Dec. 4 | 252 | " | 73 | 116 | | | 18 | 16 | 10 | 7 |
| 260 | " | 1874 | Dec. 7 | 255 | " | 76 | 114 | | | 19 | 19 | 11 | 8 |

## TABLE XI. — *Continued.*

| No. | Observer. | Date. | | Long. of Sun. | Lat. of Obs. | *t.* | Elong. of Vert. | Lat. of Boundaries. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | |
| | | | | | | | | N. | S. | N. | S. | N. | S. |
| | | | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 261 | Weber | 1875 | Jan. 24 | 304 | 52.0 | 139 | 95 | | | 13 | 13 | | |
| 262 | " | 1875 | Jan. 28 | 308 | " | 139 | 97 | | | 15 | 11 | | |
| 263 | " | 1875 | Feb. 5 | 316 | " | 144 | 104 | | | 13 | 8 | | |
| 264 | " | 1875 | Feb. 7 | 318 | " | 153 | 103 | | | 14 | 7 | | |
| 265 | " | 1875 | Feb. 22 | 333 | " | 171 | 96 | 24 | 11 | 12 | 6 | | |
| 266 | " | 1875 | Feb. 25 | 336 | " | 174 | 95 | 25 | 11 | 12 | 4 | | |
| 267 | " | 1875 | Mar. 26 | 5 | " | 214 | 100 | 25 | 20 | 14 | 10 | 7 | 1 |
| 268 | " | 1875 | Mar. 28 | 7 | " | 216 | 98 | 26 | 19 | 15 | 10 | | |
| 269 | " | 1875 | April 5 | 15 | " | 232 | 98 | 26 | 19 | 16 | 10 | | |
| 270 | " | 1875 | April 23 | 33 | " | 250 | 117 | | | 21 | 13 | 12 | 6 |
| 271 | " | 1875 | April 26 | 36 | " | 260 | 115 | | | 20 | 11 | | |
| 272 | " | 1875 | May 1 | 40 | " | 264 | 116 | | | 24 | 9 | | |
| 273 | Eylert | 1873 | May 27 | 66 | 25.3 | 282 | 80 | 13 | 8 | 13 | 0 | | |
| 274 | " | 1873 | May 28 | 67 | 22.9 | 291 | 80 | 25 | 5 | 12 | 2 | | |
| 275 | " | 1873 | June 12 | 81 | *2.8* | 276 | 73 | 23 | 9 | 3 | 3 | | |
| 276 | " | 1873 | June 13 | 82 | *4.4* | 282 | 64 | 26 | 13 | 4 | 1 | | |
| 277 | " | 1873 | June 15 | 84 | *9.1* | 284 | 69 | 35 | 12 | 9 | 3 | | |
| 278 | " | 1873 | June 16 | 85 | *10.8* | 265 | 64 | 17 | 12 | 3 | 2 | | |
| 279 | " | 1873 | June 22 | 91 | *15.8* | 286 | 60 | 27 | 15 | | | | |
| 280 | " | 1873 | July 15 | 112 | *35.3* | 313 | 66 | 6 | 21 | 2 | 3 | | |
| 281 | " | 1873 | July 17 | 114 | *35.9* | 320 | 80 | 9 | 26 | 6 | 6 | | |
| 282 | " | 1873 | Aug. 11 | 139 | *34.6* | 335 | 62 | 10 | 9 | *3* | 4 | | |
| 283 | " | 1873 | Aug. 23 | 150 | *34.6* | 353 | 78 | | | 7 | 11 | | |
| 284 | " | 1873 | Sept. 13 | 170 | *35.2* | 16 | 72 | 14 | 15 | 6 | 10 | | |
| 285 | " | 1873 | Nov. 13 | 231 | *5.8* | 79 | 86 | | | 10 | 13 | | |
| 286 | " | 1873 | Nov. 14 | 232 | *3.9* | 74 | 74 | 10 | 20 | 11 | 1 | | |
| 287 | " | 1873 | Nov. 21 | 239 | 5.6 | 76 | 70 | 15 | 15 | 11 | *1* | | |
| 288 | " | 1873 | Dec. 8 | 256 | 20.0 | 96 | | | | 7 | 6 | 7 | *1* |
| 289 | " | 1873 | Dec. 9 | 257 | 20.7 | 112 | | | | 8 | 4 | 8 | *1* |
| 290 | " | 1873 | Dec. 18 | 266 | 33.4 | 106 | | | | 12 | 8 | 1 | 8 |
| 291 | " | 1873 | Dec. 20 | 268 | 34.9 | 99 | | 3 | | 8 | 8 | 8 | 2 |
| 292 | " | 1873 | Dec. 21 | 269 | 35.4 | 105 | 110 | | | 14 | 11 | 8 | 3 |
| 293 | Neumayer | 1859 | Sept. 24 | 181 | *37.8* | 26 | | 14 | 14 | 2 | 10 | | |
| 294 | " | 1860 | Aug. 8 | 136 | *37.8* | 332 | 68 | 12 | 13 | 1 | 2 | | |
| 295 | " | 1864 | July 31 | 128 | *29.3* | 354 | 94 | | | 3 | 10 | | |
| 296 | " | 1864 | Aug. 2 | 130 | *23.3* | 341 | | | | 4 | 6 | | |

## TABLE XII. — EVENING OBSERVATIONS: SCHMIDT.

| No. | Date. | | Lat. of Obs. | Incl. of Ecl. | Az. of Pole. | Long. of Sun. | Elong. of Zen. | Latitude of Boundaries. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Elong. 30° | | Elong. 60° | | Elong. 90° | | Elong. 120° | | Elong. 150° | |
| | | | | | | | | N. | S. | N. | S. | N. | S. | N. | S. | N. | S. |
| 1 | 1855 | Dec. 1 | 49°.6 | 49° | 31° | 249° | 144° | ° | ° | ° | ° | 8° | 4° | 3° | 3° | 4° | 0° |
| 2 | 1855 | Dec. 3 | 49.6 | 39 | 38 | 251 | 121 | | | | | 8 | 2 | 2 | 3 | 6 | *1* |
| 3 | 1855 | Dec. 4 | 49.6 | 54 | 26 | 252 | 154 | | | 8 | 5 | 9 | 0 | 6 | 0 | 6 | *3* |
| 4 | 1855 | Dec. 10 | 49.6 | 56 | 23 | 258 | 152 | | | 8 | 2 | 6 | 2 | 5 | 1 | 6 | *3* |
| 5 | 1848 | Dec. 20 | 50.7 | 54 | 25 | 268 | 139 | | | 8 | 3 | 2 | 8 | | | | |
| 6 | 1848 | Dec. 21 | 50.7 | 54 | 25 | 269 | 139 | | | 9 | | 6 | 5 | 5 | 0 | | |
| 7 | 1848 | Dec. 22 | 50.7 | 54 | 25 | 270 | 138 | | | 8 | 3 | 6 | 0 | 5 | *1* | | |
| 8 | 1848 | Dec. 23 | 50.7 | 50 | 29 | 271 | 128 | | | 8 | 3 | 6 | 0 | 4 | *1* | | |
| 9 | 1851 | Jan. 2 | 50.7 | 53 | 26 | 282 | 124 | | | 7 | 5 | 5 | 1 | 4 | *1* | | |
| 10 | 1850 | Jan. 13 | 50.7 | 54 | 25 | 293 | 115 | | | 7 | 2 | 5 | *1* | 4 | *2* | | |
| 11 | 1855 | Jan. 13 | 49.6 | 50 | 30 | 293 | 103 | 10 | | 7 | 4 | 5 | 0 | 3 | *2* | | |
| 12 | 1850 | Jan. 14 | 50.7 | 56 | 21 | 294 | 119 | 10 | | 7 | 2 | 5 | 0 | 4 | *2* | | |
| 13 | 1851 | Jan. 22 | 50.7 | 58 | 18 | 302 | 117 | 13 | | 7 | 3 | 5 | 0 | | | | |
| 14 | 1851 | Jan. 23 | 50.7 | 58 | 18 | 303 | 117 | 15 | 10 | 8 | 3 | 5 | 0 | | | | |
| 15 | 1849 | Jan. 26 | 50.7 | 61 | 11 | 306 | 127 | | | 6 | 5 | 4 | *1* | | | | |
| 16 | 1851 | Jan. 30 | 50.7 | 59 | 15 | 310 | 114 | 11 | | 7 | 3 | 4 | *1* | | | | |
| 17 | 1850 | Feb. 8 | 50.7 | 62 | 4 | 319 | 123 | 12 | 6 | 8 | 0 | 4 | *2* | | | | |
| 18 | 1849 | Feb. 11 | 50.7 | 62 | 3 | 322 | 122 | | | 8 | 1 | 3 | *1* | | | | |
| 19 | 1851 | Feb. 18 | 50.7 | 62 | 3 | 329 | 116 | 13 | | 7 | 1 | 4 | *3* | | | | |
| 20 | 1851 | Feb. 23 | 50.7 | 62 | 3 | 334 | 110 | 13 | 6 | 6 | 1 | 3 | *1* | | | | |
| 21 | 1851 | Feb. 24 | 50.7 | 62 | 2 | 335 | 112 | 14 | | 7 | 3 | 3 | *1* | | | | |
| 22 | 1850 | Mar. 5 | 50.7 | 62 | 354 | 345 | 114 | 9 | 3 | 3 | *1* | | | | | | |
| 23 | 1850 | Mar. 6 | 50.7 | 62 | 354 | 346 | 114 | 9 | 9 | 5 | 1 | | | | | | |
| 24 | 1850 | Mar. 9 | 50.7 | 61 | 353 | 349 | 118 | 11 | 6 | 5 | 2 | | | | | | |
| 25 | 1850 | Mar. 10 | 50.7 | 61 | 350 | 350 | 113 | 9 | 5 | 5 | 1 | | | | | | |
| 26 | 1855 | Mar. 11 | 41.9 | 71 | 358 | 351 | 102 | | | 5 | 0 | | | | | | |
| 27 | 1855 | Mar. 14 | 41.9 | 71 | 354 | 354 | 108 | 9 | 6 | 5 | 0 | | | | | | |
| 28 | 1850 | Mar. 15 | 50.7 | 60 | 349 | 355 | 114 | 8 | 6 | 5 | 2 | | | | | | |
| 29 | 1855 | Mar. 16 | 41.9 | 69 | 348 | 356 | 119 | 8 | 12 | 4 | *1* | | | | | | |
| 30 | 1855 | Mar. 18 | 41.9 | 70 | 352 | 357 | 108 | 8 | 10 | 3 | 1 | | | | | | |
| 31 | 1855 | Mar. 19 | 41.9 | 71 | 355 | 358 | 102 | | 15 | 3 | 5 | | | | | | |
| 32 | 1850 | Mar. 31 | 50.7 | 55 | 337 | 10 | 119 | 7 | 8 | 2 | 1 | | | | | | |
| 33 | 1851 | April 1 | 50.7 | 57 | 340 | 11 | 114 | 9 | 6 | 2 | 1 | | | | | | |
| 34 | 1855 | April 16 | 40.9 | 66 | 342 | 26 | 102 | 12 | 2 | | | | | | | | |
| 35 | 1855 | April 17 | 40.9 | 66 | 341 | 27 | 102 | 12 | 14 | 6 | 3 | | | | | | |
| 36 | 1855 | May 5 | 40.9 | 59 | 334 | 44 | 103 | 10 | 6 | 5 | 1 | | | | | | |
| 37 | 1855 | May 6 | 40.9 | 53 | 330 | 45 | 115 | 17 | | 7 | 3 | 4 | *2* | | | | |

## TABLE XIII. — MONTHLY MEANS FROM TABLE X.

| No. | Month. | | No. of Days. | No. of Obs. | Lat. of Obs. | Incl. of Ecl. | Az. of Pole. | Long. of Sun. | Elong. of Zen. | Elongation of Vertex. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Stronger. | | | Diffuse. | | |
| | | | | | | | | | | No. | Sum. | Mean. | No. | Sum. | Mean. |
| 1 | 1853 | April | 8 | 17 | 19° | 89° | 345° | 18° | 109° | 15 | 718° | 47.9° | 3 | 226° | 75.3° |
| 2 | " | June | 8 | 21 | 26 | 48 | 339 | 94 | 124 | 19 | 1237 | 65.1 | 9 | 978 | 108.7 |
| 3 | " | July | 8 | 19 | 31 | 40 | 342 | 103 | 125 | 13 | 748 | 57.5 | 18 | 1670 | 92.8 |
| 4 | " | Aug. | 4 | 5 | 22 | 45 | 359 | 146 | 123 | 3 | 164 | 54.7 | 5 | 400 | 80.0 |
| 5 | " | Sept. | 5 | 13 | 23 | 46 | 13 | 177 | 124 | 6 | 320 | 53.3 | 11 | 680 | 61.8 |
| 6 | " | Oct. | 11 | 34 | 22 | 54 | 22 | 207 | 123 | 15 | 822 | 54.8 | 28 | 2455 | 87.7 |
| 7 | " | Nov. | 3 | 8 | 22 | 73 | 24 | 225 | 151 | 7 | 589 | 84.1 | 7 | 774 | 110.6 |
| 8 | " | Dec. | 4 | 19 | 22 | 82 | 19 | 276 | 123 | 15 | 1209 | 80.6 | 15 | 1916 | 127.7 |
| 9 | 1854 | Jan. | 9 | 25 | 24 | 88 | 6 | 297 | 139 | 18 | 1437 | 79.8 | 21 | 2764 | 131.6 |
| 10 | " | Feb. | 8 | 22 | 35 | 78 | 1 | 331 | 116 | 22 | 1754 | 79.7 | | | |
| 11 | " | Mar. | 7 | 16 | 35 | 72 | 342 | 5 | 122 | 12 | 1027 | 85.6 | 6 | 680 | 113.3 |
| 12 | " | April | 9 | 23 | 35 | 64 | 335 | 32 | 117 | 21 | 1924 | 91.6 | 21 | 2363 | 112.5 |
| 13 | " | May | 7 | 17 | 42 | 44 | 328 | 58 | 118 | 16 | 1416 | 88.5 | 16 | 1870 | 116.9 |
| 14 | " | June | 5 | 10 | 34 | 39 | 338 | 93 | 130 | 10 | 1032 | 103.2 | 10 | 1276 | 127.6 |
| 15 | " | July | 10 | 24 | 25 | 43 | 348 | 117 | 128 | 23 | 2287 | 99.4 | 23 | 2826 | 122.9 |
| 16 | " | Aug. | 7 | 17 | 16 | 51 | 0 | 147 | 123 | 17 | 1518 | 89.3 | 6 | 614 | 102.3 |
| 17 | " | Sept. | 6 | 14 | 28 | 40 | 13 | 174 | 125 | 8 | 591 | 73.9 | 4 | 446 | 111.5 |
| 18 | " | Oct. | 9 | 21 | 32 | 43 | 24 | 202 | 127 | 2 | 155 | 77.5 | 14 | 1364 | 97.4 |
| 19 | " | Nov. | 4 | 7 | 30 | 56 | 27 | 233 | 123 | 6 | 410 | 68.3 | 5 | 439 | 87.8 |
| 20 | " | Dec. | 13 | 29 | 34 | 66 | 24 | 262 | 129 | 26 | 2136 | 82.2 | 25 | 2661 | 106.4 |
| 21 | 1855 | Jan. | 11 | 39 | 4 | 104 | 16 | 292 | 118 | 36 | 3746 | 104.1 | | | |
| 22 | " | Feb. | 7 | 12 | *38* | 151 | 355 | 322 | 136 | 12 | 1318 | 109.8 | | | |
| 23 | " | Mar. | 5 | 14 | *23* | 134 | 346 | 356 | 127 | 8 | 618 | 77.2 | | | |
| 24 | " | Apr. | 8 | 22 | 18 | 85 | 340 | 22 | 125 | 18 | 2073 | 115.2 | 2 | 260 | 130.0 |

## TABLE XIV. — MONTHLY MEANS FROM TABLE X.

**Latitude of Boundaries : Stronger Light.**

| No. | Elongation 30° | | | | | | Elongation 60° | | | | | | Elongation 90° | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N. | | | S. | | | N. | | | S. | | | N. | | | S. | | |
| | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean |
| 1 | 16 | 99° | 6.2° | 16 | 84° | 5.2° | 1 | 3° | 3.0° | 1 | 2° | 2.0° | | ° | ° | | ° | ° |
| 2 | 18 | 486 | 27.0 | 2 | 4 | 2.0 | 10 | 218 | 21.8 | 5 | 47 | 9.4 | 2 | 45 | 22.5 | 1 | 12 | 12.0 |
| 3 | 11 | 239 | 21.7 | 2 | 12 | 6.0 | 3 | 44 | 14.7 | 3 | 10 | 3.3 | | | | | | |
| 4 | 3 | 50 | 16.7 | | | | | | | | | | | | | | | |
| 5 | 5 | 89 | 17.8 | | | | 1 | 4 | 4.0 | 1 | 3 | 3.0 | | | | | | |
| 6 | 11 | 213 | 19.4 | 4 | 15 | 3.8 | 3 | 39 | 13.0 | 3 | 28 | 9.3 | 2 | 15 | 7.5 | 2 | 9 | 4.5 |
| 7 | | | | | | | 4 | 72 | 18.0 | 3 | 30 | 10.0 | 3 | 24 | 8.0 | 3 | 24 | 8.0 |
| 8 | 2 | 32 | 16.0 | 2 | 20 | 10.0 | 15 | 138 | 9.2 | 14 | 123 | 8.8 | 3 | 24 | 8.0 | 3 | 21 | 7.0 |
| 9 | 2 | 19 | 9.5 | 2 | 14 | 7.0 | 15 | 124 | 8.3 | 15 | 106 | 7.1 | 3 | 13 | 4.3 | 3 | 11 | 3.7 |
| 10 | 7 | 84 | 12.0 | 7 | 51 | 7.3 | 20 | 167 | 8.4 | 20 | 144 | 7.2 | 5 | 17 | 3.4 | 5 | 20 | 4.0 |
| 11 | 4 | 39 | 9.8 | 4 | 26 | 6.5 | 13 | 116 | 8.9 | 13 | 67 | 5.2 | 6 | 53 | 8.8 | 6 | 17 | 2.8 |
| 12 | 2 | 31 | 15.5 | 2 | 15 | 7.5 | 21 | 230 | 11.0 | 21 | 112 | 5.3 | 13 | 85 | 6.5 | 13 | 19 | 1.5 |
| 13 | 14 | 375 | 26.8 | | | | 16 | 203 | 12.7 | 15 | 45 | 3.0 | 11 | 73 | 6.6 | 11 | 32 | 2.9 |
| 14 | 2 | 54 | 27.0 | | | | 10 | 169 | 16.9 | 10 | 34 | 3.4 | 9 | 80 | 8.9 | 9 | 24 | 2.7 |
| 15 | 2 | 33 | 16.5 | 2 | 5 | 2.5 | 22 | 302 | 13.7 | 22 | 53 | 2.4 | 19 | 175 | 9.2 | 19 | 12 | 0.6 |
| 16 | 3 | 50 | 16.7 | | | | 16 | 204 | 12.8 | 15 | 50 | 3.3 | 6 | 41 | 6.8 | 6 | 0 | 0.0 |
| 17 | 10 | 233 | 23.3 | 3 | 14 | 4.7 | 11 | 90 | 8.2 | 11 | 18 | 1.6 | | | | | | |
| 18 | 12 | 278 | 23.2 | 1 | 4 | 4.0 | 9 | 51 | 5.7 | 2 | 8 | 4.0 | | | | | | |
| 19 | 1 | 12 | 12.0 | | | | 6 | 29 | 4.8 | 6 | 28 | 4.7 | | | | | | |
| 20 | 4 | 27 | 6.8 | | | | 25 | 165 | 6.6 | 25 | 106 | 4.2 | 4 | 18 | 4.5 | 3 | 11 | 3.7 |
| 21 | 13 | 114 | 8.8 | 13 | 145 | 11.2 | 35 | 229 | 6.5 | 36 | 353 | 9.8 | 33 | 120 | 3.6 | 33 | 184 | 5.6 |
| 22 | | | | 3 | 65 | 21.7 | 9 | 56 | 6.2 | 9 | 123 | 13.7 | 12 | 18 | 1.5 | 12 | 104 | 8.7 |
| 23 | | | | 5 | 64 | 12.8 | 11 | 28 | 2.5 | 13 | 124 | 9.5 | | | | | | |
| 24 | 6 | 69 | 11.5 | 7 | 94 | 13.4 | 20 | 217 | 10.8 | 21 | 203 | 9.7 | 19 | 161 | 8.5 | 19 | 99 | 5.2 |

## TABLE XV.—MONTHLY MEANS FROM TABLE X.

Latitude of Boundaries : Diffuse Light.

| No. | Elongation 60° | | | | | | Elongation 90° | | | | | | Elongation 120° | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N. | | | S. | | | N. | | | S. | | | N. | | | S. | | |
| | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean |
| | | ° | ° | | ° | ° | | ° | ° | | ° | ° | | ° | ° | | ° | ° |
| 1 | 4 | 68 | 17.0 | 5 | 23 | 4.6 | | | | | | | | | | | | |
| 2 | 9 | 262 | 29.1 | 5 | 64 | 12.8 | 6 | 174 | 29.0 | 4 | 74 | 18.5 | 4 | 94 | 23.5 | 4 | 81 | 20.2 |
| 3 | 19 | 501 | 26.4 | 3 | 52 | 17.3 | 11 | 189 | 17.2 | 11 | 146 | 13.3 | | | | | | |
| 4 | 5 | 122 | 24.4 | 3 | 53 | 17.7 | 1 | 8 | 8.0 | 1 | 6 | 6.0 | | | | | | |
| 5 | 6 | 97 | 16.1 | 4 | 40 | 10.0 | | | | | | | | | | | | |
| 6 | 22 | 648 | 29.5 | 3 | 52 | 17.3 | 18 | 281 | 15.6 | 15 | 239 | 15.9 | | | | | | |
| 7 | 1 | 24 | 24.0 | 1 | 26 | 26.0 | 6 | 177 | 29.5 | 7 | 157 | 22.4 | | | | | | |
| 8 | 13 | 287 | 22.1 | 15 | 319 | 21.3 | 15 | 280 | 18.7 | 14 | 224 | 16.0 | 6 | 85 | 14.2 | 6 | 82 | 13.7 |
| 9 | 12 | 273 | 22.8 | 12 | 198 | 16.5 | 19 | 318 | 16.7 | 19 | 273 | 14.4 | 17 | 172 | 10.1 | 17 | 182 | 10.7 |
| 10 | 15 | 334 | 22.3 | 15 | 250 | 16.7 | 11 | 166 | 15.1 | 15 | 202 | 13.5 | | | | | | |
| 11 | 4 | 92 | 23.0 | 9 | 119 | 13.2 | 6 | 106 | 17.7 | 5 | 47 | 9.4 | | | | | | |
| 12 | 21 | 463 | 22.0 | 2 | 30 | 15.0 | 21 | 435 | 20.7 | 21 | 243 | 11.6 | | | | | | |
| 13 | 16 | 516 | 32.2 | 15 | 264 | 17.6 | 16 | 451 | 28.2 | 16 | 237 | 14.8 | 3 | 64 | 21.3 | 3 | 28 | 9.3 |
| 14 | 10 | 358 | 35.8 | 1 | 18 | 18.0 | 10 | 303 | 30.3 | 10 | 168 | 16.8 | 8 | 160 | 20.0 | 8 | 87 | 10.9 |
| 15 | 23 | 805 | 35.0 | 2 | 30 | 15.0 | 23 | 690 | 30.0 | 23 | 338 | 14.7 | 15 | 252 | 16.8 | 15 | 75 | 5.0 |
| 16 | 12 | 397 | 33.1 | 8 | 159 | 19.9 | 12 | 282 | 23.5 | 9 | 117 | 13.0 | | | | | | |
| 17 | 12 | 414 | 34.5 | 3 | 32 | 10.7 | 4 | 85 | 21.2 | 4 | 72 | 18.0 | | | | | | |
| 18 | 14 | 437 | 31.2 | | | | 13 | 202 | 15.5 | 13 | 147 | 11.3 | | | | | | |
| 19 | 5 | 148 | 29.6 | 5 | 94 | 18.8 | 2 | 30 | 15.0 | 2 | 22 | 11.0 | | | | | | |
| 20 | 22 | 532 | 24.2 | 20 | 404 | 20.2 | 23 | 412 | 17.9 | 23 | 270 | 11.7 | 3 | 20 | 6.7 | 3 | 23 | 7.7 |
| 21 | 17 | 321 | 18.9 | 17 | 386 | 22.7 | 17 | 211 | 12.4 | 17 | 302 | 17.8 | 11 | 76 | 6.9 | 12 | 150 | 12.5 |
| 22 | | | | 8 | 235 | 29.4 | 7 | 99 | 14.1 | 11 | 260 | 23.6 | | | | 9 | 150 | 16.7 |
| 23 | 5 | 63 | 12.6 | 11 | 295 | 26.8 | | | | 9 | 166 | 18.4 | | | | | | |
| 24 | 14 | 358 | 25.6 | 17 | 405 | 23.8 | 14 | 323 | 23.1 | 15 | 249 | 16.6 | 13 | 273 | 21.0 | 15 | 127 | 8.5 |

## TABLE XVI. — MONTHLY RESULTS FROM TABLE X.

**Stronger Light.**

| No | Latitude of Axis. | | | | | | | | | Half Extent in Latitude. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Elong. 30° | | | Elong. 60° | | | Elong. 90° | | | Elong. 30° | | | Elong. 60° | | | Elong. 90° | | |
| | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean |
| 1 | 16 | 7° | 0°.4 | 1 | 0° | 0°.0 | | ° | ° | 16 | 91° | 5°.7 | 1 | 2° | 2°.0 | | ° | ° |
| 2 | 2 | 11 | 5.5 | 5 | 24 | 4.8 | 1 | 4 | 4.0 | 2 | 15 | 7.5 | 5 | 69 | 13.8 | 1 | 16 | 16.0 |
| 3 | 2 | 14 | 7.0 | 3 | 17 | 5.7 | | | | 2 | 25 | 12.5 | 3 | 27 | 9.0 | | | |
| 4 | | | | | | | | | | | | | | | | | | |
| 5 | | | | 1 | 0 | 0.0 | | | | | | | 1 | 4 | 4.0 | | | |
| 6 | 4 | 26 | 6.5 | 3 | 6 | 2.0 | 2 | 3 | 1.5 | 4 | 40 | 10.0 | 3 | 34 | 11.3 | 2 | 12 | 6.0 |
| 7 | | | | 3 | 12 | 4.0 | 3 | 0 | 0.0 | | | | 3 | 41 | 13.7 | 3 | 24 | 8.0 |
| 8 | 2 | 6 | 3.0 | 14 | 3 | 0.2 | 3 | 2 | 0.7 | 2 | 26 | 13.0 | 14 | 126 | 9.0 | 3 | 22 | 7.3 |
| 9 | 2 | 3 | 1.5 | 15 | 8 | 0.5 | 3 | 1 | 0.3 | 2 | 16 | 8.0 | 15 | 115 | 7.7 | 3 | 12 | 4.0 |
| 10 | 7 | 16 | 2.3 | 20 | 11 | 0.5 | 5 | *2* | *0.4* | 7 | 67 | 9.5 | 20 | 153 | 7.6 | 5 | 19 | 3.8 |
| 11 | 4 | 7 | 1.7 | 13 | 24 | 1.8 | 6 | 18 | 3.0 | 4 | 33 | 8.2 | 13 | 92 | 7.1 | 6 | 35 | 5.8 |
| 12 | 2 | 7 | 3.5 | 21 | 59 | 2.8 | 13 | 33 | 2.5 | 2 | 22 | 11.0 | 21 | 171 | 8.1 | 13 | 50 | 3.8 |
| 13 | | | | 15 | 68 | 4.5 | 11 | 20 | 1.8 | | | | 15 | 114 | 7.6 | 11 | 52 | 4.7 |
| 14 | | | | 10 | 67 | 6.7 | 9 | 28 | 3.1 | | | | 10 | 101 | 10.1 | 9 | 52 | 5.8 |
| 15 | 2 | 14 | 7.0 | 22 | 125 | 5.7 | 19 | 82 | 4.3 | 2 | 19 | 9.5 | 22 | 176 | 8.0 | 19 | 93 | 4.9 |
| 16 | | | | 15 | 70 | 4.7 | 6 | 20 | 3.3 | | | | 15 | 119 | 7.9 | 6 | 18 | 3.0 |
| 17 | 3 | 27 | 9.0 | 11 | 36 | 3.3 | | | | 3 | 41 | 13.7 | 11 | 53 | 4.8 | | | |
| 18 | 1 | 8 | 8.0 | 2 | 1 | 0.5 | | | | 1 | 12 | 12.0 | 2 | 8 | 4.0 | | | |
| 19 | | | | 6 | 0 | 0.0 | | | | | | | 6 | 29 | 4.8 | | | |
| 20 | | | | 25 | 29 | 1.2 | 3 | 1 | 0.3 | | | | 25 | 133 | 5.3 | 3 | 12 | 4.0 |
| 21 | 13 | *15* | *1.2* | 35 | *55* | *1.6* | 33 | *31* | *0.9* | 13 | 128 | 9.8 | 35 | 284 | 8.1 | 33 | 152 | 4.6 |
| 22 | | | | 9 | *33* | *3.7* | 12 | *42* | *3.5* | | | | 9 | 89 | 9.9 | 12 | 60 | 5.0 |
| 23 | | | | 11 | *35* | *3.2* | | | | | | | 11 | 63 | 5.7 | | | |
| 24 | 6 | *4* | *0.7* | 20 | 11 | 0.5 | 19 | 30 | 1.6 | 6 | 72 | 12.0 | 20 | 203 | 10.2 | 19 | 127 | 6.7 |

## TABLE XVII. — MONTHLY RESULTS FROM TABLE X.

**Diffuse Light.**

| No. | Latitude of Axis. | | | | | | | | | Half Extent in Latitude. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Elong. 60° | | | Elong. 90° | | | Elong. 120° | | | Elong. 60° | | | Elong. 90° | | | Elong. 120° | | |
| | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean | No. | Sum | Mean |
| 1 | 4 | 24° | 6.0° | | ° | ° | | ° | ° | 4 | 44° | 11.0° | | ° | ° | | ° | ° |
| 2 | 5 | 17 | 3.4 | 4 | 16 | 4.0 | 4 | 6 | 1.5 | 5 | 82 | 16.4 | 4 | 90 | 22.5 | 4 | 88 | 22.0 |
| 3 | 3 | 10 | 3.3 | 11 | 21 | 1.9 | | | | 3 | 62 | 20.7 | 11 | 165 | 15.0 | | | |
| 4 | 3 | 4 | 1.3 | 1 | 1 | 1.0 | | | | 3 | 58 | 19.3 | 1 | 7 | 7.0 | | | |
| 5 | 4 | 14 | 3.5 | | | | | | | 4 | 54 | 13.5 | | | | | | |
| 6 | 2 | 5 | 2.5 | 15 | *8* | *0.5* | | | | 2 | 37 | 18.5 | 15 | 228 | 15.2 | | | |
| 7 | 1 | *1* | *1.0* | 6 | 20 | 3.3 | | | | 1 | 25 | 25.0 | 6 | 155 | 25.8 | | | |
| 8 | 13 | 9 | 0.7 | 14 | 17 | 1.2 | 6 | 1 | 0.2 | 13 | 279 | 21.5 | 14 | 238 | 17.0 | 6 | 84 | 14.0 |
| 9 | 12 | 37 | 3.1 | 19 | 24 | 1.3 | 17 | *4* | *0.2* | 12 | 234 | 19.5 | 19 | 294 | 15.5 | 17 | 177 | 10.4 |
| 10 | 16 | 47 | 2.9 | 11 | 12 | 1.1 | | | | 16 | 313 | 19.6 | 11 | 153 | 13.9 | | | |
| 11 | 4 | 18 | 4.5 | 5 | 20 | 4.0 | | | | 4 | 74 | 18.5 | 5 | 67 | 13.4 | | | |
| 12 | 2 | 3 | 1.5 | 21 | 95 | 4.5 | | | | 2 | 33 | 16.5 | 21 | 340 | 16.2 | | | |
| 13 | 15 | 110 | 7.3 | 16 | 107 | 6.7 | 3 | 20 | 6.7 | 15 | 374 | 24.9 | 16 | 345 | 21.6 | 3 | 46 | 15.3 |
| 14 | 1 | 7 | 7.0 | 10 | 67 | 6.7 | 8 | 36 | 4.5 | 1 | 25 | 25.0 | 10 | 236 | 23.6 | 8 | 123 | 15.4 |
| 15 | 2 | 21 | 10.5 | 23 | 174 | 7.6 | 15 | 86 | 5.7 | 2 | 50 | 25.0 | 23 | 519 | 22.6 | 15 | 163 | 10.9 |
| 16 | 8 | 49 | 6.1 | 9 | 45 | 5.0 | | | | 8 | 209 | 26.1 | 9 | 164 | 18.2 | | | |
| 17 | 3 | 31 | 10.3 | 4 | 12 | 3.0 | | | | 3 | 63 | 21.0 | 4 | 77 | 19.2 | | | |
| 18 | | | | 13 | 23 | 1.8 | | | | | | | 13 | 174 | 13.4 | | | |
| 19 | 5 | 26 | 5.1 | 2 | 4 | 2.0 | | | | 5 | 117 | 23.4 | 2 | 26 | 13.0 | | | |
| 20 | 20 | 41 | 2.0 | 23 | 70 | 3.0 | 3 | *1* | *0.3* | 20 | 445 | 22.2 | 23 | 340 | 14.8 | 3 | 21 | 7.0 |
| 21 | 17 | *33* | *1.9* | 17 | *50* | *2.9* | 11 | *32* | *2.9* | 17 | 353 | 20.8 | 17 | 257 | 15.1 | 11 | 108 | 9.8 |
| 22 | | | | 7 | *30* | *4.3* | | | | | | | 7 | 128 | 18.3 | | | |
| 23 | 5 | *34* | *6.8* | | | | | | | 5 | 97 | 19.4 | | | | | | |
| 24 | 14 | 10 | 0.7 | 14 | 43 | 3.1 | 13 | 76 | 5.8 | 14 | 348 | 24.9 | 14 | 279 | 19.9 | 13 | 192 | 14.8 |

## TABLE XVIII. — MONTHLY RESULTS FROM TABLE X.

| No. | Stronger Light. | | | | | | | | | | Diffuse Light. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | From 30° to 60°. | | | | | From 60° to 90°. | | | | | From 60° to 90°. | | | | | From 90° to 120°. | | | | |
| | | Displ. | | Contr. | | | Displ. | | Contr. | | | Displ. | | Contr. | | | Displ. | | Contr. | |
| | No. | Sum. | Mean. | Sum. | Mean. | No. | Sum. | Mean. | Sum. | Mean. | No. | Sum. | Mean. | Sum. | Mean. | No. | Sum. | Mean. | Sum. | Mean. |
| 1 | 1 | 5° | 5.0° | 3° | 3.0° | | ° | ° | ° | ° | | ° | ° | ° | ° | | ° | ° | ° | ° |
| 2 | | | | | | | | | | | 2 | 8 | 4.0 | 26 | 13.0 | 2 | *1* | *0.5* | 17 | 8.5 |
| 3 | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | 1 | *2* | *2.0* | 12 | 12.0 | | | | | |
| 7 | | | | | | 1 | *4* | *4.0* | 5 | 5.0 | 1 | *1* | *1.0* | 12 | 12.0 | | | | | |
| 8 | 2 | *6* | *3.0* | 10 | 5.0 | 2 | 0 | 0.0 | 9 | 4.5 | 12 | 1 | 0.1 | 61 | 5.1 | 6 | *4* | *0.7* | 23 | 3.8 |
| 9 | 2 | *3* | *1.5* | 7 | 3.5 | 1 | 0 | 0.0 | 7 | 7.0 | 12 | *20* | *1.7* | 60 | 5.0 | 15 | *24* | *1.6* | 94 | 6.3 |
| 10 | 5 | *11* | *2.2* | 17 | 3.4 | 5 | *9* | *1.8* | 25 | 5.0 | 11 | *23* | *2.1* | 56 | 5.1 | | | | | |
| 11 | 3 | 0 | 0.0 | 15 | 5.0 | 6 | 3 | 0.5 | 18 | 3.0 | 2 | 3 | 1.5 | 11 | 5.5 | | | | | |
| 12 | 2 | *2* | *1.0* | 6 | 3.0 | 13 | *2* | *0.2* | 62 | 4.8 | 2 | 9 | 4.5 | *2* | *1.0* | | | | | |
| 13 | | | | | | 10 | *34* | *3.4* | 41 | 4.1 | 15 | *9* | *0.6* | 51 | 3.4 | 3 | *4* | *1.3* | 28 | 9.3 |
| 14 | | | | | | 9 | *35* | *3 9* | 41 | 4.6 | 1 | *2* | *2.0* | 5 | 5.0 | 8 | *23* | *2.9* | 73 | 9.1 |
| 15 | 2 | *6* | *3.0* | 8 | 4.0 | 18 | *30* | *1.7* | 65 | 3.6 | 2 | *7* | *3.5* | 8 | 4.0 | 15 | *43* | *2.9* | 196 | 13.1 |
| 16 | | | | | | 5 | *12* | *2.4* | 30 | 6.0 | 6 | *7* | *1.2* | 46 | 7.7 | | | | | |
| 17 | 3 | *16* | *5.3* | 26 | 8.7 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | 2 | *4* | *2.0* | 27 | 13.5 | | | | | |
| 20 | | | | | | 2 | *4* | *2.0* | 8 | 4.0 | 20 | 22 | 1.1 | 145 | 7.2 | 1 | 2 | 2.0 | 14 | 14.0 |
| 21 | 13 | 6 | 0.5 | 46 | 3.5 | 32 | 26 | 0.8 | 123 | 3.8 | 17 | *17* | *1.0* | 96 | 5.6 | 11 | 3 | 0.3 | 60 | 5.5 |
| 22 | | | | | | 9 | 12 | 1.3 | 40 | 4.4 | | | | | | | | | | |
| 23 | | | | | | | | | | | | | | | | | | | | |
| 24 | 6 | 8 | 1.3 | 25 | 4.2 | 19 | 20 | 1.1 | 70 | 3.7 | 14 | 33 | 2.4 | 69 | 4.9 | 13 | 35 | 2.7 | 69 | 5.3 |

## TABLE XIX. — MONTHLY MEANS FROM TABLE XI.

| No. | Month. | No. of Obs. | Lat. of Obs. | Incl. of Ecl. | Az. of Pole. | Long. of Sun. | Elong. of Zen. | Elongation of Vertex. |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  | Inner Cone. |  |  | Outer Cone. |  |  |
|  |  |  |  |  |  |  |  | No. | Sum. | Mean. | No. | Sum. | Mean. |
|  | **HEIS.** |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | ° | ° | ° | ° | ° |  | ° | ° |  | ° | ° |
| 1 | January | 38 | 52 | 55 | 22 | 296 | 120 |  |  |  | 38 | 3359 | 88.4 |
| 2 | February | 44 | 52 | 61 | 4 | 326 | 118 |  |  |  | 44 | 3730 | 84.8 |
| 3 | March | 51 | 52 | 60 | 354 | 354 | 114 | 1 | 45 | 45.0 | 51 | 3495 | 68.5 |
| 4 | April | 30 | 52 | 51 | 332 | 23 | 113 |  |  |  | 30 | 2107 | 70.2 |
| 5 | May | 3 | 52 | 40 | 322 | 44 | 118 |  |  |  | 3 | 215 | 71.7 |
| 6 | July | 1 | 52 | 21 | 35 | 119 | 212 |  |  |  | 1 | 94 | 94.0 |
| 7 | August | 1 | 52 | 22 | 37 | 137 | 198 |  |  |  | 1 | 96 | 96.0 |
| 8 | November | 1 | 52 | 43 | 35 | 238 | 149 |  |  |  | 1 | 85 | 85.0 |
| 9 | December | 16 | 52 | 47 | 32 | 265 | 130 |  |  |  | 16 | 1341 | 83.8 |
|  | **WEBER.** |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | January | 14 | 52 | 58 | 17 | 299 | 122 | 2 | 169 | 84.5 | 14 | 1209 | 86.4 |
| 2 | February | 19 | 52 | 61 | 4 | 326 | 116 | 4 | 306 | 76.5 | 19 | 1692 | 89.1 |
| 3 | March | 26 | 52 | 60 | 349 | 356 | 112 | 2 | 134 | 67.0 | 26 | 2210 | 85.0 |
| 4 | April | 21 | 52 | 52 | 333 | 25 | 108 | 2 | 145 | 72.5 | 21 | 1839 | 87.6 |
| 5 | May | 2 | 52 | 45 | 326 | 42 | 108 |  |  |  | 2 | 181 | 90.5 |
| 6 | December | 5 | 52 | 42 | 37 | 261 | 119 |  |  |  | 5 | 509 | 101.8 |

## TABLE XX. — MONTHLY MEANS FROM TABLE XI.

Latitude of Boundaries.

| No. | Elongation 30° |  |  |  |  |  | Elongation 60° |  |  |  |  |  | Elongation 90° |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | N |  |  | S. |  |  | N. |  |  | S. |  |  | N. |  |  | S. |  |  |
|  | No. | Sum. | Mean. | No. | Sum. | Mean. | No. | Sum. | Mean. | No. | Sum. | Mean. | No. | Sum. | Mean. | No. | Sum. | Mean. |
|  | **HEIS.** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | ° | ° |  | ° | ° |  | ° | ° |  | ° | ° |  | ° | ° |  | ° | ° |
| 1 | 12 | 272 | 22.7 | 7 | 84 | 12.0 | 37 | 539 | 14.6 | 37 | 332 | 9.0 | 11 | 59 | 5.4 | 11 | 39 | 3.5 |
| 2 | 10 | 224 | 22.4 | 8 | 112 | 14.0 | 44 | 629 | 14.3 | 44 | 373 | 8.5 | 4 | 26 | 6.5 | 4 | 1 | 0.2 |
| 3 | 40 | 863 | 21.6 | 38 | 445 | 11.7 | 39 | 373 | 9.6 | 39 | 203 | 5.2 | 2 | 9 | 4.5 | 2 | 2 | 1.0 |
| 4 | 20 | 422 | 21.1 | 17 | 210 | 12.4 | 23 | 229 | 10.0 | 23 | 127 | 5.5 |  |  |  |  |  |  |
| 5 | 2 | 42 | 21.0 |  |  |  | 3 | 33 | 11.0 | 3 | 15 | 5.0 |  |  |  |  |  |  |
| 6 | 1 | 43 | 43.0 |  |  |  | 1 | 32 | 32.0 |  |  |  | 1 | 12 | 12.0 |  |  |  |
| 7 |  |  |  |  |  |  | 1 | 18 | 18.0 | 1 | 4 | 4.0 |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  | 1 | 8 | 8.0 | 1 | 2 | 2.0 |  |  |  |  |  |  |
| 9 | 7 | 191 | 27.3 | 6 | 49 | 8.2 | 16 | 254 | 15.9 | 16 | 95 | 5.9 | 2 | 17 | 8.5 | 2 | 7 | 3.5 |
|  | **WEBER.** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 8 | 69 | 23.0 | 3 | 27 | 9.0 | 14 | 193 | 13.8 | 14 | 109 | 7.8 |  |  |  |  |  |  |
| 2 | 9 | 213 | 23.7 | 9 | 139 | 15.4 | 19 | 224 | 11.8 | 19 | 123 | 6.5 | 2 | 7 | 3.5 | 2 | 2 | 1.0 |
| 3 | 17 | 360 | 21.2 | 17 | 242 | 14.2 | 26 | 259 | 10.0 | 26 | 171 | 6.6 | 5 | 18 | 3.6 | 5 | 15 | 3.0 |
| 4 | 6 | 120 | 20.0 | 5 | 63 | 12.6 | 20 | 253 | 12.6 | 20 | 153 | 7.6 | 5 | 44 | 8.8 | 5 | 15 | 3.0 |
| 5 | 1 | 18 | 18.0 | 1 | 14 | 14.0 | 2 | 31 | 15.5 | 2 | 8 | 4.0 |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  | 4 | 58 | 14.5 | 4 | 50 | 12.5 | 4 | 38 | 9.5 | 4 | 26 | 6.5 |

## TABLE XXI. — Monthly Results from Table XI.

| No. | Heis. | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Latitude of Axis. | | | | | | | | | Half Extent in Latitude. | | | | | | | | |
| | Elong. 30° | | | Elong. 60° | | | Elong. 90° | | | Elong. 30° | | | Elong. 60° | | | Elong. 90° | | |
| | No. | Sum. | Mean. | No. | Sum. | Mean. | No. | Sum. | Mean. | No. | Sum. | Mean. | No. | Sum. | Mean. | No. | Sum. | Mean. |
| 1 | 7 | 38° | 5°.4 | 37 | 100° | 2°.7 | 14 | 11° | 0°.8 | 7 | 121° | 17°.3 | 37 | 436° | 11°.8 | 11 | 49° | 4°.5 |
| 2 | 8 | 29 | 3.6 | 44 | 124 | 2.8 | 10 | 18 | 1.8 | 8 | 141 | 17.6 | 44 | 501 | 11.4 | 4 | 14 | 3.5 |
| 3 | 38 | 185 | 4.9 | 41 | 91 | 2.2 | 3 | 3 | 1.0 | 38 | 630 | 16.6 | 39 | 287 | 7.4 | 2 | 5 | 2.5 |
| 4 | 17 | 69 | 4.1 | 26 | 56 | 2.2 | | | | 17 | 280 | 16.5 | 23 | 176 | 7.7 | | | |
| 5 | | | | 3 | 9 | 3.0 | | | | | | | 3 | 24 | 8.0 | | | |
| 6 | | | | | | | | | | | | | | | | | | |
| 7 | | | | 1 | 7 | 7.0 | | | | | | | 1 | 11 | 11.0 | | | |
| 8 | | | | 1 | 3 | 3.0 | | | | | | | 1 | 5 | 5.0 | | | |
| 9 | 6 | 66 | 11.0 | 16 | 77 | 4.8 | 4 | 17 | 4.2 | 6 | 116 | 19.3 | 16 | 174 | 10.9 | 2 | 12 | 6.0 |
| | Weber. | | | | | | | | | | | | | | | | | |
| 1 | 3 | 21 | 7.0 | 14 | 43 | 3.1 | 4 | 6 | 1.5 | 3 | 48 | 16.0 | 14 | 151 | 10.8 | | | |
| 2 | 9 | 36 | 4.0 | 19 | 49 | 2 6 | 5 | 8 | 1.6 | 9 | 174 | 19.3 | 19 | 173 | 9.1 | 2 | 4 | 2.0 |
| 3 | 17 | 54 | 3.2 | 26 | 47 | 1.8 | 7 | 4 | 0.6 | 17 | 306 | 18.0 | 26 | 214 | 8.2 | 5 | 17 | 3.4 |
| 4 | 5 | 21 | 4.2 | 21 | 51 | 2.4 | 5 | 15 | 3.0 | 5 | 83 | 16.6 | 20 | 202 | 10.1 | 5 | 30 | 6.0 |
| 5 | 1 | 2 | 2.0 | 2 | 11 | 5.5 | | | | 1 | 16 | 16.0 | 2 | 19 | 9.5 | | | |
| 6 | | | | 4 | 3 | 0.8 | 4 | 7 | 1.8 | | | | 4 | 55 | 13.7 | 4 | 32 | 8.0 |

## TABLE XXII. — Monthly Results from Table XI.

| No. | Heis. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | From 30° to 60° | | | | | | From 60° to 90° | | | | | |
| | Displ. | | | Contr. | | | Displ. | | | Contr. | | |
| | No. | Sum. | Mean. | No. | Sum. | Mean. | No. | Sum. | Mean. | No. | Sum. | Mean. |
| 1 | 7 | *11°* | *1°.6* | 7 | 56° | 8°.0 | 13 | *25°* | *1°.9* | 10 | 100° | 10°.0 |
| 2 | 8 | *16* | *2.0* | 8 | 70 | 8.8 | 10 | *12* | *1.2* | 4 | 48 | 12.0 |
| 3 | 28 | *89* | *3.2* | 26 | 293 | 11.3 | 3 | *3* | *1.0* | 2 | 20 | 10.0 |
| 4 | 13 | *33* | *2.5* | 10 | 108 | 10.8 | | | | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | 6 | *20* | *3.3* | 6 | 49 | 8.2 | 4 | 0 | 0.0 | 2 | 13 | 6.5 |
| | Weber. | | | | | | | | | | | |
| 1 | 3 | *8* | *2.7* | 3 | 25 | 8.3 | 4 | *1* | *0.2* | | | |
| 2 | 9 | *9* | *1.0* | 9 | 95 | 10.6 | 5 | *1* | *0 2* | 2 | 15 | 7.5 |
| 3 | 17 | *20* | *1.2* | 17 | 174 | 10.2 | 7 | 0 | 0 0 | 5 | 42 | 8.4 |
| 4 | 5 | *7* | *1.4* | 4 | 37 | 9.2 | 5 | *2* | *0.4* | 5 | 38 | 7.6 |
| 5 | 1 | 2 | 2.0 | 1 | 13 | 13.0 | | | | | | |
| 6 | | | | | | | 3 | *1* | *0.3* | 3 | 29 | 9.7 |

## TABLE XXIII. — Results from Table X.

Stronger Light.

| Group. | Incl. of Ecl. | Elong. of Zen. | Elongation of Vertex. | | Latitude of Boundaries. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | N. Elong. 30° S. | | | | N. Elong. 60° S. | | | | N. Elong. 90° S. | | | |
| | | | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. |
| 1 | 43° | 125° | 100 | 79°.5 | 77 | 23°.9 | 10 | 3°9 | 82 | 13°.2 | 69 | 3°.2 | 41 | 9°.1 | 40 | 2°.0 |
| 2 | 53 | 123 | 38 | 72.4 | 15 | 18.3 | 4 | 3.8 | 25 | 10.9 | 24 | 4.4 | 8 | 7.0 | 8 | 1.1 |
| 3 | 65 | 124 | 47 | 86.4 | 6 | 9.7 | 2 | 7.5 | 46 | 8.6 | 46 | 4.7 | 17 | 6.1 | 16 | 1.9 |
| 4 | 79 | 124 | 74 | 89.9 | 19 | 11.8 | 20 | 9.6 | 72 | 9.9 | 71 | 8.0 | 36 | 7.8 | 36 | 5.0 |
| 5 | 88 | 127 | 33 | 65.3 | 18 | 6.6 | 18 | 5.4 | 16 | 7.9 | 16 | 6.8 | 3 | 4.3 | 3 | 3.7 |
| 6 | 104 | 118 | 36 | 104.1 | 13 | 8.8 | 13 | 11.2 | 35 | 6.5 | 36 | 9.8 | 33 | 3.6 | 33 | 5.6 |
| 7 | 142 | 131 | 20 | 96.8 | | | 8 | 16.1 | 20 | 4.2 | 22 | 11.2 | 12 | 1.5 | 12 | 8.7 |

## TABLE XXIV. — Results from Table X.

Diffuse Light.

| Group. | Lat. of Obs. | Z. D. of Sun. | Elongation of Vertex. | | Latitude of Boundaries. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | N. Elong. 60° S. | | | | N. Elong. 90° S. | | | | N. Elong. 120° S. | | | |
| | | | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. |
| 1 | 30° | 113° | 110 | 104°.6 | 114 | 30°.8 | 36 | 15°4 | 84 | 25°.0 | 82 | 14°.5 | 30 | 19°.0 | 30 | 9°.0 |
| 2 | 21 | 116 | 39 | 89.9 | 39 | 30.6 | 16 | 19.1 | 32 | 18.5 | 26 | 14.5 | | | | |
| 3 | 34 | 121 | 46 | 109.2 | 43 | 23.1 | 22 | 19.7 | 44 | 19.2 | 44 | 11.7 | 3 | 6.7 | 3 | 7.7 |
| 4 | 27 | 123 | 30 | 121.0 | 47 | 23.3 | 57 | 19.6 | 52 | 20.2 | 56 | 15.7 | 19 | 18.8 | 21 | 10.0 |
| 5 | 22 | 127 | 24 | 124.6 | 16 | 21.3 | 17 | 13.0 | 19 | 16.7 | 19 | 14.4 | 17 | 10.1 | 17 | 10.7 |
| 6 | 4 | 117 | | | 17 | 18.9 | 17 | 22.7 | 17 | 12.4 | 17 | 17.8 | 11 | 6.9 | 12 | 12.5 |
| 7 | *30* | 114 | | | 5 | 12.6 | 19 | 27.9 | 7 | 14.1 | 20 | 21.3 | | | 9 | 16.7 |

## TABLE XXV. — Results from Table X.

Stronger Light.

| Group. | Elong. 30° | | | Elong. 60° | | | Elong. 90° | | | From 30° to 60° | | | From 60° to 90° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Axis. | Ext. | No. | Axis. | Ext. | No. | Axis. | Ext. | No. | Displ. | Contr. | No. | Displ. | Contr. |
| 1 | 10 | 7°.4 | 11°.2 | 69 | 4°.9 | 8°.0 | 40 | 3°.4 | 5°.3 | 5 | *4°.4* | 6°.8 | 37 | *2°.7* | 4°.0 |
| 2 | 4 | 6.5 | 10.0 | 24 | 3.2 | 7.6 | 8 | 2.9 | 3.7 | | | | 5 | *2.4* | 6 0 |
| 3 | 2 | 3.5 | 11 0 | 46 | 1.9 | 6.6 | 16 | 2.1 | 3.9 | 2 | *1.0* | 3.0 | 15 | *0.4* | 4.7 |
| 4 | 19 | 1.3 | 10.4 | 70 | 0.9 | 8.8 | 36 | 1.3 | 6.3 | 16 | *0.6* | 4 2 | 33 | 0.3 | 3.8 |
| 5 | 18 | 0.6 | 5.9 | 16 | 0.5 | 7.3 | 3 | 0.3 | 4.0 | 3 | 0.7 | 3.3 | 1 | 0.0 | 7.0 |
| 6 | 13 | *1.2* | 9.8 | 35 | *1 6* | 8.1 | 33 | *0.9* | 4.6 | 13 | 0.5 | 3.5 | 32 | 0.8 | 3.8 |
| 7 | | | | 20 | *3.4* | 7.6 | 12 | *3.5* | 5.0 | | | | 9 | 1.3 | 4.4 |

## TABLE XXVI. — RESULTS FROM TABLE X.

Diffuse Light.

| Group. | Elong. 60° | | | Elong. 90° | | | Elong. 120° | | | From 60° to 90° | | | From 90° to 120° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Axis. | Ext. | No. | Axis. | Ext. | No. | Axis. | Ext. | No. | Displ. | Contr. | No. | Displ. | Contr. |
| 1 | 36 | 5°.9 | 21°.3 | 82 | 5°.1 | 19°.7 | 30 | 4°.9 | 14°.0 | 20 | *0°.5* | 4°.5 | 28 | *2°.5* | 11°.2 |
| 2 | 15 | 5.3 | 24.2 | 26 | 1.6 | 16.1 | | | | 9 | *1.4* | 9.4 | | | |
| 3 | 22 | 2.0 | 21.7 | 44 | 3.8 | 15.5 | 3 | *0.3* | 7.0 | 22 | 1.4 | 6.5 | 1 | 2.0 | 14.0 |
| 4 | 48 | 1.7 | 21.6 | 50 | 2.2 | 17.8 | 19 | 4.1 | 14.5 | 40 | 3.2 | 5.2 | 19 | 1.6 | 4.8 |
| 5 | 16 | 3.8 | 17.4 | 19 | 1.3 | 15.5 | 17 | *0.2* | 10.4 | 12 | *1.7* | 5.0 | 15 | *1.6* | 6.3 |
| 6 | 17 | *1.9* | 20.8 | 17 | *2.9* | 15.1 | 11 | *2.9* | 9.8 | 17 | *1.0* | 5.6 | 11 | 0.3 | 5.5 |
| 7 | 5 | *6.8* | 19.4 | 7 | *4.3* | 18.3 | | | | | | | | | |

## TABLE XXVII. — RESULTS FROM TABLE XI.

| Group. | Incl. of Ecl. | Elong. of Zen. | Elongation of Vertex. | | Latitude of Boundaries. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | N. Elong. 30° | | S. | | N. Elong. 60° | | S. | | N. Elong. 90° | | S. | |
| | | | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean | No. | Mean | No. | Mean. |
| HEIS. | | | | | | | | | | | | | | | | |
| 1 | 46° | 129° | 20 | 82°.0 | 9 | 25°.9 | 6 | 8°.2 | 20 | 14°.8 | 20 | 5°.6 | 2 | 8°.5 | 2 | 3°.5 |
| 2 | 53 | 117 | 68 | 80.4 | 32 | 21.7 | 24 | 12.2 | 60 | 12.8 | 60 | 7.6 | 11 | 5.4 | 11 | 3.5 |
| 3 | 60 | 116 | 95 | 76.1 | 50 | 21.7 | 46 | 12.1 | 83 | 12.1 | 83 | 6.9 | 6 | 5.8 | 6 | 0.5 |
| WEBER. | | | | | | | | | | | | | | | | |
| 1 | 43 | 116 | 7 | 98.6 | 1 | 18.0 | 1 | 14.0 | 6 | 14.8 | 6 | 9.7 | 4 | 9.5 | 4 | 6.5 |
| 2 | 54 | 114 | 35 | 87.1 | 9 | 21.0 | 8 | 11.2 | 34 | 13.1 | 34 | 7.7 | 5 | 8.8 | 5 | 3.0 |
| 3 | 60 | 114 | 45 | 86.7 | 26 | 22.0 | 26 | 14.7 | 45 | 10.7 | 45 | 6.5 | 7 | 3.6 | 7 | 2.4 |

## TABLE XXVIII. — RESULTS FROM TABLE XI.

| Group. | Elong. 30° | | | | Elong. 60° | | | | Elong. 90° | | | | From 30° to 60° | | | | From 60° to 90° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Axis. | No. | Ext. | No. | Axis. | No. | Ext. | No. | Axis. | No. | Ext. | No. | Displ. | No. | Contr. | No. | Displ. | No. | Contr. |
| HEIS. | | | | | | | | | | | | | | | | | | | | |
| 1 | 6 | 11°.0 | 6 | 19°.3 | 20 | 4°.4 | 20 | 10°.2 | 4 | 4°.2 | 2 | 6°.0 | 6 | *3°.3* | 6 | 8°.2 | 4 | 0°.0 | 2 | 6°.5 |
| 2 | 24 | 4.5 | 24 | 16.7 | 63 | 2.5 | 60 | 10.2 | 14 | 0.8 | 11 | 4.5 | 20 | *2.2* | 17 | 9.6 | 13 | *1.9* | 10 | 10.0 |
| 3 | 46 | 4.7 | 46 | 16.8 | 85 | 2.5 | 83 | 9.5 | 13 | 1.6 | 6 | 3.2 | 36 | *2.9* | 34 | 10.7 | 13 | *1.2* | 6 | 11.3 |
| WEBER. | | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 2.0 | 1 | 16.0 | 6 | 2.3 | 6 | 17.3 | 4 | 1.8 | 4 | 8.0 | 1 | 2.0 | 1 | 13.0 | 3 | *0.3* | 3 | 9.7 |
| 2 | 8 | 5.2 | 8 | 16.4 | 35 | 2.7 | 34 | 1[illegible].4 | 9 | 2.3 | 5 | 6.0 | 8 | *1.9* | 7 | 8.9 | 9 | *0.3* | 5 | 7.6 |
| 3 | 26 | 3.5 | 26 | 18.5 | 45 | 2.1 | 45 | 8.6 | 12 | 1.0 | 7 | 3.0 | 26 | *1.1* | 26 | 10.3 | 12 | *0.1* | 7 | 8.1 |

### TABLE XXIX. — RESULTS FROM TABLE XI.: EYLERT AND NEUMAYER.

| Group. | Incl. of Ecl. | Elong. of Zen. | Elongation of Vertex. | | Latitude of Boundaries. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | N. Elong. 30° S. | | | | N. Elong. 60° S. | | | | N. Elong. 90° S. | | | |
| | | | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. |
| 1 | 63° | 120° | 3 | 90°.0 | 3 | 13°.7 | 2 | 6°.5 | 5 | 11°.8 | 5 | 5°.8 | 3 | 5°.7 | 3 | 4°.3 |
| 2 | 77 | 119 | 1 | 70.0 | 1 | 15.0 | 1 | 15.0 | 3 | 8.7 | 3 | 3.0 | 2 | 7.5 | 2 | *1.0* |
| 3 | 91 | 118 | 6 | 83.3 | 4 | 23.5 | 4 | 13.5 | 7 | 6.3 | 7 | 5.3 | | | | |
| 4 | 104 | 111 | 8 | 68.8 | 8 | 13.6 | 8 | 15.6 | 8 | 3.0 | 8 | 6.0 | | | | |

### TABLE XXX. — RESULTS: EYLERT AND NEUMAYER.

| Group. | Lat. of Obs. | Z. D. of Sun. | Elong. Vert. Inner Cone. | | Latitude of Boundaries. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | N. Elong. 120° S. | | | | N. Elong. 150° S. | | | | N. Elong. 180° S. | | | |
| | | | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. |
| 1 | 30° | 117° | | | 2 | *7°.5* | 2 | 16°.5 | | | | | | | | |
| 2 | 15 | 118 | | | 2 | *1.0* | 2 | 9.0 | 2 | *12°.5* | 2 | 18°.0 | 2 | *17°.5* | 2 | 24°.5 |
| 3 | *11* | 118 | 1 | 53°.0 | | | | | | | | | | | | |
| 4 | *31* | 110 | 3 | 55.7 | | | | | | | | | | | | |

### TABLE XXXI. — RESULTS: EYLERT AND NEUMAYER.

| Group. | Elong. 30° | | | Elong. 60° | | | Elong. 90° | | | From 30° to 60° | | | From 60° to 90° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Axis. | Ext. | No. | Axis. | Ext. | No. | Axis. | Ext. | No. | Displ. | Contr. | No. | Displ. | Contr. |
| 1 | 2 | 6°.5 | 12°.5 | 5 | 3°.0 | 8°.6 | 3 | 0°.3 | 4°.7 | 2 | *1°.0* | 6°.0 | 3 | *1°.0* | 5°.3 |
| 2 | 1 | 0.0 | 15.0 | 3 | 2.7 | 6.0 | 2 | 4.0 | 3.0 | 1 | 6.0 | 10.0 | 2 | 3.0 | 3.5 |
| 3 | 4 | 5.2 | 18.7 | 7 | 0.6 | 5.7 | | | | 4 | *3.0* | 14.5 | | | |
| 4 | 8 | *0.9* | 14.8 | 9 | *1.2* | 4.0 | | | | 8 | *0.2* | 10.1 | | | |

### TABLE XXXII. — RESULTS: EYLERT AND NEUMAYER.

| Group. | Elong. 120° | | | Elong. 150° | | | Elong. 180° | | | From 90° to 120° | | | From 120° to 150° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Axis. | Ext. | No. | Axis. | Ext. | No. | Axis. | Ext. | No. | Displ. | Contr. | No. | Displ. | Contr. |
| 1 | 2 | *11°.5* | 10°.0 | | | | | | | 2 | *11°.0* | *5°.5* | | | |
| 2 | 2 | *5.0* | 4.0 | 2 | *15°.0* | 2°.8 | 2 | *21°.0* | 3°.5 | 2 | *9.0* | *1.0* | 2 | *10°.0* | 1°.2 |
| 3 | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | |

## TABLE XXXIII. — RESULTS FROM TABLE XII.

| Group. | Lat. of Obs. | Incl. of Ecl. | Elong. of Zen. | Z. D. of Sun. | Latitude of Boundaries. | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | N. Elong. 30° S. | | | | N. Elong. 60° S. | | | | N. Elong. 90° S. | | | | N. Elong. 120° S. | | | |
| | | | | | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. | No. | Mean. |
| 1 | 50° | 47° | 124° | 114° | 1 | 10.0° | | ° | 2 | 7.5° | 2 | 3.5° | 4 | 6.8° | 4 | 1.5° | 4 | 3.0° | 4 | 0.8° |
| 2 | 50 | 55 | 130 | 121 | 4 | 10.8 | 2 | 7.0 | 11 | 6.6 | 10 | 2.7 | 9 | 5.3 | 9 | 1.4 | 7 | 4.7 | 7 | *0.7* |
| 3 | 50 | 61 | 116 | 112 | 13 | 11.3 | 9 | 6.3 | 15 | 6.1 | 15 | 1.7 | 9 | 3.9 | 9 | *1.1* | | | | |
| 4 | 42 | 69 | 106 | 105 | 5 | 9.8 | 6 | 9.8 | 6 | 4.3 | 6 | 1.3 | | | | | | | | |

## TABLE XXXIV. — RESULTS FROM TABLE XII.

| Group. | Elong. 30° | | | Elong. 60° | | | Elong. 90° | | | Elong. 120° | | | From 30° to 60° | | | From 60° to 90° | | | From 90° to 120° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Axis. | Ext. | No. | Axis. | Ext. | No. | Axis. | Ext. | No. | Axis. | Ext. | No. | Displ. | Contr. | No. | Displ. | Contr. | No. | Displ. | Contr. |
| 1 | | ° | ° | 2 | 2.0° | 5.5° | 4 | 2.5° | 4.0° | 4 | 1.5° | 2.2° | | ° | ° | 2 | 0.5° | 3.0° | 4 | *1.0*° | 1.8° |
| 2 | 2 | 0.5 | 7.5 | 10 | 2.0 | 4.4 | 9 | 1.8 | 3.3 | 7 | 2.4 | 2.1 | 2 | 1.0 | 6.0 | 8 | *0.1* | 2 1 | 7 | 0.1 | 1.3 |
| 3 | 9 | 2.0 | 8.4 | 15 | 2.1 | 4.0 | 9 | 2.1 | 1.6 | | | | 9 | 0.1 | 5.0 | 9 | *0.2* | 3.2 | | | |
| 4 | 5 | 0.6 | 9.2 | 6 | 1.3 | 2.7 | | | | | | | 4 | 2.2 | 7.2 | | | | | | |

## TABLE XXXV. — ATMOSPHERIC ABSORPTION.

| Z. D. | Abs. | Z. D. | Abs. | Z. D. | Abs. | Z. D. | Abs. | Z. D. | Abs. | Z. D. | Abs. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 17° | 0.01 | 29° | 0.03 | 41° | 0.07 | 53° | 0.15 | 65° | 0.32 | 77° | 0.76 |
| 18 | 0.01 | 30 | 0.03 | 42 | 0.07 | 54 | 0.16 | 66 | 0.34 | 78 | 0.82 |
| 19 | 0.01 | 31 | 0.03 | 43 | 0.08 | 55 | 0.17 | 67 | 0.36 | 79 | 0.90 |
| 20 | 0.01 | 32 | 0.03 | 44 | 0.08 | 56 | 0.18 | 68 | 0.39 | 80 | 0.98 |
| 21 | 0.01 | 33 | 0.04 | 45 | 0.09 | 57 | 0.19 | 69 | 0.42 | 81 | 1.07 |
| 22 | 0.01 | 34 | 0.04 | 46 | 0.09 | 58 | 0.20 | 70 | 0.45 | 82 | 1.18 |
| 23 | 0.01 | 35 | 0.04 | 47 | 0.10 | 59 | 0.22 | 71 | 0.48 | 83 | 1.32 |
| 24 | 0.02 | 36 | 0.05 | 48 | 0.11 | 60 | 0.23 | 72 | 0.52 | 84 | 1.49 |
| 25 | 0.02 | 37 | 0.05 | 49 | 0.11 | 61 | 0.25 | 73 | 0.56 | 85 | 1.72 |
| 26 | 0.02 | 38 | 0.05 | 50 | 0.12 | 62 | 0.26 | 74 | 0.60 | 86 | 2.04 |
| 27 | 0.02 | 39 | 0.06 | 51 | 0.13 | 63 | 0.28 | 75 | 0.65 | 87 | 2.48 |
| 28 | 0.02 | 40 | 0.06 | 52 | 0.14 | 64 | 0.30 | 76 | 0.70 | 88 | 3.10 |